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THE chapter of the Essentials of Mechanical Drawing in the present number completes their publication in the JOURNAL. The author is now engaged in revising the articles as published, and they will be issued in book form, with some additions, as soon as the revision is completed.

OUR readers will note that the pressure upon our space has made it necessary to remove the "Index to Advertisements" from the cover to an inside page. At the same time, it has been made fuller than heretofore.

THE Drexel Institute in Philadelphia, which was formally opened December 17, owes its existence to Mr. A. J. Drexel of that city, who gave $1,500,000 for the building and endowment. It is intended to be a practical and industrial institution somewhat on the plan of the Cooper Institute in New York. It will have departments of art, science, business economy, etc., and a school for teachers, while combined with these are a museum and library. There will also be lectures and evening classes. The manual training system will have a prominent part.

AN experimental fast run was recently made on the Northern Railroad of France, from Paris to Calais, with a train of 12 passenger cars weighing 310,000 lbs. without the engine. The run of 185 miles was made with two stops, at the rate of 54 miles an hour actual running time. The highest speed attained was 67 miles an hour, on a down grade of 26.4 ft. to the mile; this was almost equaled on a level, where 66½ miles an hour was reached.

The locomotive which made this run had four driving-wheels coupled and a four-wheeled truck, the drivers being 83 in. in diameter. The engine is a four-cylinder compound of the Du Bousquet type, the cylinders arranged in tandem and the exhaust from the high-pressure cylinders passing directly through the valve into the low-pressure cylinders. The cylinders are 13.4 and 20.9 in. × 25.2 in.; the proportion between the high and low-pressure cylinders is 1 : 2.43. It may be added that this type of compound has been in use on freight trains on the Northern Railroad for some time, but has only been tried in passenger service very recently.

THE month of December was notable for the launching of three vessels for the Navy, and in another column will be found accounts of the great armored cruiser *New York*, the cruiser *Montgomery*, and the gunboat *Machias*, which were all put in the water during the month. Gunboat No. 6, a sister ship to the *Machias*, and the Naval Academy practice ship will follow soon, probably during the present month.

THE Nicaragua Canal had a very favorable mention in the President's message, and the New York Chamber of Commerce has passed resolutions expressing high appreciation of the advantages to be gained by its construction. It is becoming apparent that if the canal is to be built as a distinctively American enterprise, Government endorsement in some form will be needed. The demands for capital in the United States have been so great heretofore that our people have not become accustomed to investments outside of our own borders, and the difficulties of securing the money for an enterprise of the magnitude of the Nicaragua Canal are very great.

The canal ought to be built, and it ought to be under American control; the way is not quite clear at present, but it is to be hoped that some plan for providing the capital may soon be decided on.

PLANS for a triple-expansion locomotive have been made by a German engineer, who proposes to put the high-pressure and intermediate cylinders outside and the low-pressure inside, connecting all three with the same axle.

THE "Deep Water Ways Convention," which met at Detroit on December 17, had for its objects the urging upon Congress the importance of maintaining a depth of at least 21 ft. in the lake channels, and of ship communication between Lake Ontario and the Atlantic; the last to be attained by enlarging the Erie Canal by a new canal from Oswego through the Mohawk Valley to the Hudson, or by the St. Lawrence River. The last named could hardly be considered an American project, and was strongly opposed by the Eastern delegates.

THE construction of a ship canal from Lake Erie to Lake Ontario is proposed in a bill introduced in Congress by Senator Davis, of West Virginia. It provides for the building of a canal on one of the lines heretofore surveyed, the channel to be of a size sufficient to pass any vessel which can go through the locks on the Sault Ste. Marie Canal. The bill will not have much chance at the present session.

THE rapid transit question is almost at a stand in New York. The report of the Commission has been duly approved by the Mayor and Aldermen, and the work to be done at present is the obtaining the consent of property owners along the proposed lines. This proceeds slowly, and so far does not promise well, the consents obtained being chiefly of owners of uptown property, which will be benefited by the building of new roads, while in some of the streets further down-town there is active opposition. Meanwhile public opinion seems to be somewhat uncertain as to underground lines; at any rate, there is no strong feeling in their favor, and the present prospect of

any result from the work of the Commission is not encouraging.

THE present indications are that 1892 will be a good year for the car and locomotive builders. The heavy crops of the year just closed have caused a demand for freight cars, and there is everywhere a complaint of scarcity of rolling stock. For the first quarter of the year traffic will be large, and the railroad companies will be generally able to pay for the new cars they need. Moreover, many roads are looking forward to a heavy travel to the Chicago Exhibition next year, and will want new passenger cars to prepare for it. These considerations will apply to the locomotive business as well, and unless there is an unexpected change, there will be much new work.

SAFETY CAR COUPLERS.

THE latest scheme for securing the adoption and use of a uniform standard coupler is embodied in a bill recently introduced into the United States Senate by Senator Cullom.

The bill provides that all common carriers and all employers of such carriers whose duties include the coupling of cars, and who are members of established organizations of railway employés, may, within six months after the passage of this act, vote upon the choice of an automatic car coupler. Such coupler may be of the vertical type, but must be so devised as to couple by impact and to dispense with any person going between the cars to couple or uncouple.

Every common carrier is to be entitled to one vote for every freight car owned, leased, or controlled, and the employés entitled in the aggregate to one-third as many votes as may be cast by all the common carriers, the Interstate Commerce Commission to have the power to decide upon the validity of the votes cast. If not less than 600,000 votes have been cast, and the entire vote for any particular coupler is not less than 500,000, the commission shall certify these facts to the President, who shall issue a proclamation declaring the coupler chosen to be the standard safety car coupler for use in Interstate Commerce. And in case no choice is made, the President shall appoint a commission of five competent persons to determine the coupler best to be used. The bill further provides that all carriers are to equip at least 10 per cent. each year of the number of freight cars used, and also to equip every engine with the power brake known as the "driving wheel brake."

The bill provides further that a violation of the act shall be considered a misdemeanor and punishable by a fine of $500. The Commission may extend the time to any particular company within which it shall be required to comply with the provisions of the bill, and after the year 1900 any company may refuse to accept any car not equipped as required by the bill. The bill also provides that the commission shall invite bids from inventors of couplers, stating what they will accept from the United States for their patents, and upon the purchase of the patent by the Government the coupler may be used or manufactured by anybody free. The salary of the commissioners is fixed at $5,000 a year, and an appropriation of $70,000 is made to carry out the proposed measure.

The aim of this bill apparently is to secure, by a system of popular suffrage or a counting of noses, the selection from a vast multitude of inventions, which are the result of the exercise of the ingenuity of thousands of inventors, of an automatic coupler which will be most efficient in coupling cars, least liable to break or get out of order, and which will expose railroad operatives to the minimum amount of danger. It is safe to say that to make a wise decision on such a subject requires a very high order of mechanical knowledge and experience of the practical requirements which must be fulfilled by an automatic coupler, and more than all, an unerring judgment or "dead sureness" which, in combination with the other qualifications, is very rare indeed. Now what possible chance is there that the wisest decision will be reached by the method proposed in Mr. Cullom's bill? It provides that "all common carriers and all employés of such carriers whose duties include the coupling of cars, and who are members of established organizations of railroad employés, may vote upon the choice of an automatic coupler, and every common carrier to have one vote for every freight car owned, leased or controlled." The intelligence of the employés is evidently not rated very high, because they are entitled by the bill to only one-third as many votes as the freight cars are—that is, the bill in effect says that a railroad employé is endowed with one-third as much intelligence as the representation of a freight car confers on a common carrier. In other words, a general manager of a railroad which owns 50,000 freight cars would be assumed to have 150,000 times as much wisdom in deciding this question as a brakeman has. Now with due respect to brakemen and general managers, it may be said that neither of them have the highest qualifications to decide on the merits of automatic couplers. It is largely a mechanical question, and mechanical skill, knowledge, experience and sound judgment have more value in determining what coupler is the best than any other qualifications whatever.

If it was proposed to apply the method suggested by Mr. Cullom for providing a remedy for the risks and dangers of car coupling to the mitigation of some other risks and dangers to which mankind is exposed, its ineffectiveness would be apparent. Probably more people are disabled and die from the grippe than from coupling cars, and the doctors admit that they know of no sufficient remedy for the disease. Now supposing that, in view of the great loss of life and health resulting from the grippe, and the great need of a remedy, that some member of Congress was to introduce a bill giving all who have suffered from the disease a right to vote for a cure, and giving each hospital association a vote for every bed it provides, and then compel the doctors in the hospitals to administer the remedy thus agreed upon to their patients, we would be almost as likely to come to a wise decision on this subject as we will be in deciding upon a coupler by the Cullom plan. With reference to the medical question, the judgment, opinion and conclusions of a well-educated, intelligent, experienced and clear-headed doctor would be a safer guide in the adoption of a remedy for disease than the aggregate result of the counting of a great multitude of the noses of the sufferers from the ailment; and in the same way the opinion of a competent mechanical expert would be a very much safer guide in coming to a decision on the coupler question than any counting of noses can possibly be, and especially if two-thirds of those counted are the "bull-noses" of freight cars.

The bill also contemplates that "in case no choice is made, the President shall appoint a commission of five competent persons to determine the coupler best to be used; the salary of the commissioners is fixed at $5,000 per year."

The object aimed at by the popular suffrage part of the bill is not apparent. The decision of a commission of *competent* persons would certainly be safer to follow than the verdict of "not less than 600,000 votes." Then why not resort to the most trustworthy plan first? The question also arises whether a commission appointed by the President to "determine the coupler best to be used" will be as likely to consist of "*competent*" persons as it would be if this commission was created by the railroad companies. This leads to the subject which has already been discussed in these columns—that is, the creation of a

technical committee or commission by the American Railroad Association. The bill which we have been criticising seems to be a formal notice from Congress that if the railroad companies in the country will not take any adequate action to secure the adoption of uniform safety appliances, then Congress will do it for them. It will be impossible for the companies to successfully resist some national legislation of this kind unless they take adequate action looking to the same end. At present it can hardly be said that they are doing this. It becomes a question, then, whether the railroad companies will create a technical commission of their own, or whether they will have Congress do it for them. It may be said without hesitation that at present the railroad companies have no organization competent to deal with the question such as this one of automatic couplers. The members of the committees appointed by the various associations to consider such matters are not able, nor are they inclined if they could, to give the time which is required for the investigation and study of many of the subjects submitted to them. The real work of nearly all committees is, at any rate, generally done by some one member of each committee. Usually it is not well done, because no one is able to give the requisite time to the work. The need of the railroad companies is a commission with some one on it who is competent, who can give his whole time to the work and is paid liberally for doing it. Such a commission could be created by the American Railroad Association from its own members, or in part, perhaps, from members of the Master Mechanics' and Master Car-Builders' Associations, who would serve on it as the members of other committees do, merely as an advisory body, and without other compensation excepting expenses. They should be authorized to employ at an adequate salary a competent person or persons to do the work which should be done. Such a person could then give his whole time and thought to the work under the supervision and advice of the commission. In the exercise of his duties, he would accumulate much valuable experience and knowledge, and with each year his services would increase in value to those by whom he is employed. The difference in the results of the work which is done by a person who devotes his whole time, thought, energy and life to it, compared with that which is done casually and more or less perfunctorily, is the same as that which is always apparent when professional work is compared with that of an amateur.

The introduction of Mr. Cullom's bill makes it seem quite certain that if the railroad companies do not create some authority to act on questions like that of safety appliances, that Congress will do it for them.

Since the above was written, the full text of the bill has been submitted to us. Besides the above provisions, which were taken from a daily paper, it contains the following clause :

Section 10. That within 90 days from the passage of this Act the American Railroad Association is authorized hereby to designate to the Interstate Commerce Commission the standard height of draw-bars for freight cars, measured perpendicular from the level of the tops of the rails to the centers of the draw-bars, and shall fix a maximum variation to be allowed between the draw-bars of empty and loaded cars. Upon their determination being certified to the Interstate Commerce Commission, the Commission shall give notice of the standard fixed upon, at once, to all common carriers, owners or lessees engaged in Interstate commerce in the United States by such means as the Commission may deem proper, and thereafter all cars built or repaired shall be of that standard. *Provided also*, that after six months from said notice no cars shall be used in Interstate traffic which do not comply with the standard above provided for, either loaded or unloaded. Should said Association fail to determine a standard as above provided, it shall be the duty of the Interstate Commerce Commission to do so.

This latter clause is to be heartily commended ; and in the interest of humanity it is to be hoped that it will become a law. The Master Car-Builders' Association has recommended a standard height for draw-bars—2 ft. 9 in., measured perpendicularly from the tops of the rails to the center of the draw-bar when the car is empty—but railroad companies are not generally conforming to it. If they are conforming to it the law will be no hardship ; if they are not, they ought to be compelled to do so. We hope this part of Mr. Cullom's bill will become a law, but the rest of it is sure to work more harm than good.

INFORMATION REGARDING COMPOUND LOCOMOTIVES.

THE Rhode Island Locomotive Works have issued another of their admirable reports of the performance of one of their compound locomotives on the New York, Providence & Boston and the Boston & Albany railroads. The results may be briefly summed up as follows : The compound engine weighed 103,230 lbs. ; the simple engine on the Boston & Albany road weighed 91,250 lbs. ; the one on the New York, Providence & Boston road weighed 91,000 lbs.

In the first series of trials on the New York, Providence & Boston road the compound engine showed a saving of 25.2 per cent. of coal. In the second series it saved 14.52 per cent. In the first series of trials on the Boston & Albany there was a saving of 28.63 per cent., and in the second series 21.6 per cent. While these results are very favorable to the compound engine, we think the conditions were hardly fair to the simple machine. In only one of the series of experiments was account kept of the amount of water evaporated per pound of coal. That was during the series of runs when the compound engine showed a saving of 14.52 per cent. During these tests the compound boiler evaporated 7.30 lbs. of water per pound of coal, whereas the simple engine evaporated only 6.59 lbs., so that nearly 11 per cent. of the saving was due to the boiler.

The difference in the boiler performance of simple and compound locomotives is usually attributed to the fact that compound engines use less steam than simple ones do, and therefore the boilers need not be worked so hard. In this instance, however, there was only about 3½ per cent. *more* water evaporated in the simple boiler than in the compound ; and this, on the theory quoted, resulted in an increase of 11 per cent. in the amount evaporated per pound of coal. The explanation does not appear to be sufficiently explanatory.

Furthermore, the boilers of all the engines were practically of the same size ; nevertheless, the compound engine weighed 12,000 lbs. more than the simple engines. It is true that the wheels of the compound engine were 6 in. larger than the one simple engine and 8 in. larger than those of the other ; but it is fair inference that the greater portion of the difference in weight was due to the difference in construction between the compound and simple engines—that is, to the larger cylinders, additional steam pipes, intercepting valves, etc. Now to the extent to which the weight of compound locomotives is increased by their peculiarities of construction, to that extent are they a disadvantage. If the builders of the simple engines had been allowed to increase the size of their boilers

to the extent to which an addition of 12,000 lbs. to their weight would have permitted, doubtless the simple boilers would or could have shown better evaporative results.

The question is: How much better will a compound engine of a given weight do than a simple engine of the same weight? Not to hit a boy below your size is a rule that most of us learned in early youth, and the ethics underlying that rule applies to locomotives as well as to boys.

THE NAVY REPORTS.

THE report of the Secretary of the Navy emphasizes the progress made on the new vessels, and at the same time notes the rapid disappearance of the old wooden ships, few of which can be relied on for much longer service. The Secretary still adheres to the views expressed in his previous reports, and believes that we need more battleships of the class of the *Indiana* and *Massachusetts*. Beyond these he considers the armored cruiser with heavy armament, like the *New York*, the most useful and valuable class of ship that can be built for all purposes. For immediate addition to the Navy he believes that one or more torpedo cruisers, several torpedo-boats and one or more fast armored cruisers are the types most needed, with the addition of one or two light-draft vessels of good speed, with an armament of rapid-fire guns, for special river and in-shore service on the China and Asiatic stations. He does not recommend any increase in the number of cruisers of the *Detroit* or of the *Raleigh* classes.

The Secretary refers at some length to the recent tests of armor, and calls special attention to the fact that not only can the largest naval vessels be built in the United States, but that it is now possible to procure the best and heaviest armor and to make the complete armament in our own shops—a remarkable change during the past few years.

Upon the whole the recommendations of the report are well considered, and upon one point it is decidedly in the right. Time is required to build a modern warship, and if we are to have vessels at all, their building should be authorized in season.

On another point the report deserves commendation, and that is in its statement of the application of civil-service rules to the navy-yards, and the measures taken to improve the standard of the working force, and to secure really skilled labor. This policy is to be continued, and a resulting improvement is already to be noted.

Chief Engineer Melville has to report another busy year in his department. Fewer new designs for machinery have been called for; but there has been abundant work to do on the engines of the new ships, and the Bureau of Steam Engineering is fully occupied. Attention is called to the peculiar requirements in the engines of a warship and to the impossibility of meeting these and at the same time securing the same economy that is obtained in the merchant marine.

The question of improvement in the engineer force is a pressing one, and the difficulty of obtaining competent men to serve as machinists on board ship still exists. Competent men can do better on shore, and are not willing to submit to the restrictions of navy life. The need of skilled men increases with every improvement made in the new ships, and the supply is quite inadequate. Higher rating, better pay and a somewhat larger force are needed to secure the men. This difficulty is not peculiar to our own Navy, and it is the subject of serious consideration in England also. The modern warship depends so much for its efficiency upon its engineer force that the old-time complete subordination of the engineer to the fighting man can no longer be insisted on as it used to be. A full recognition of this fact would help very much to improve the present situation.

The report of Commodore Folger, Chief of the Bureau of Ordnance, has special interest this year, showing as it does the rapid progress which has been made in building heavy guns of the latest type. The great gun shop at the Washington Navy Yard is approaching complete equipment, and is already doing some notably excellent work. Not only are the 6-in., 8-in. and 10-in. guns being made ready for the new ships, but the first 12-in. gun has been tested, and several others are nearly ready, while work is in progress on the first of the 13-in. guns, the largest yet authorized. The building of an experimental gun of 16-in. caliber is recommended, and the Washington shop is ready to undertake the work. The smaller rapid-fire guns are now made in this country, and arrangements have also been made for the manufacture of armor-piercing shot.

Experiments with high explosives and torpedoes have been continued; and it is believed that the Bureau will soon be in a condition to supply the new ships with their equipment of torpedoes.

On the whole, the naval reports may be said to show good progress for the past year, with prospects of still further improvement in the future.

ENGLISH AND AMERICAN LOCOMOTIVES.*

(*Continued from page* 529, *Vol. LXV.*)

III.

SINCE the last number of the RAILROAD AND ENGINEERING JOURNAL was issued we have received a copy of the "Administrative Report on the Railways in India for 1890–91." This contains some interesting and valuable statistics relating to the performance of locomotives on Indian railways. As these lines are equipped with English locomotives, and as the nature of the traffic on them resembles that of our roads, a comparison of the performance of locomotives in that country with ours will throw some light on the question discussed in these articles.

In the year 1890 the total number of passenger, goods and mixed train miles run on the Indian railways was 72,645,950. It is not said whether this includes any mileage for switching or "shunting." Presumably it does not. If we allow 20 per cent. more for switching service we will have a total of 87,175,140 miles. The number of engines "used in conveying traffic" was 3,747, which would give an average mileage of 23,265 miles per engine, which is less than that of engines in the mother country, which was given in our November number, and it will be remembered was 24,160 miles, whereas the average mileage here was 35,650. Comment would not add to the significance of these figures. The railways of India are generally not profitable to their owners. Perhaps if they were equipped with American locomotives, which would run 50 per cent. more miles in a given time, and pull heavier

* We regret that the following mileage of locomotives on the Pennsylvania Railroad was received too late for publication in Table III, published in this series of articles in the November number of the JOURNAL. Locomotive No. 998 on that road ran 103,579 miles in the year 1886; locomotive No. 2107, on the Philadelphia & Erie division, ran 100,374 miles in 1888; locomotive No. 170, on the Philadelphia, Wilmington & Baltimore road, ran 126,152 miles in 1891. The latter beats the record.

TABLE VIII. SHOWING FUEL CONSUMPTION AND COST OF LOCOMOTIVE SERVICE ON TWELVE DIFFERENT AMERICAN RAILROADS.

1	Passenger Trains.								Freight Trains.							
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Name of Road.	Average Weight of Cars in Trains and their Loads in Tons of 2,240 Lbs.	Lbs. of Coal Consumed per Mile.	Value of Coal at 1 Mill per Lb.	Cost of Repairs per Engine, Mile.	Cost of Oil Waste and Miscellaneous Supplies per Mile.	Wages of Engineer, Fireman, and Cost of Cleaning per Mile.	Total Cost of Locomotive Service per Train, Mile.	Total Cost per Ton of Cars and of their Loads per Mile.	Average Weight of Cars in Trains and their Loads in Tons of 2,240 Lbs.	Lbs. of Coal Consumed per Mile.	Value of Coal at 1 Mill per Lb.	Cost of Repairs per Engine, Mile.	Cost of Oil Waste and Miscellaneous Supplies per Mile.	Wages of Engineer, Fireman, and Cost of Cleaning per Mile.	Total Cost of Locomotive Service per Train, Mile.	Total Cost of Locomotive Service per Ton of Cars and of their Loads per Mile.
	Tons.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Tons.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.
Chesapeake and Ohio	123.2	63.65	6.36	4.54	.29	6.59	17.78	.144	472.5	127.4	12.74	4.54	.29	6.59	24.16	.051
Chicago and Alton	139.7	72.3	7.23	3.62	.6	8.00	19.45	.139	508.0	96.1	9.61	3.62	.6	8.00	21.83	.041
Cincinnati Southern	117.9	55.0	5.50	4.4	.3	7.40	17.6	.150	570.0	98.0	9.80	4.4	.3	7.40	21.90	.038
Cleveland, Cincinnati, Chicago and St. Louis	122.8	63.21	6.32	3.19	.32	6.78	16.61	.135	535.0	106.7	10.67	3.19	.32	6.78	20.95	.039
Illinois Central	122.4	74.9	7.49	3.34	.28	6.46	17.57	.143	384.0	108.4	10.84	3.34	.28	6.46	20.92	.052
Louisville and Nashville	137.4	60.5	6.05	5.17	.27	7.98	19.47	.141	327.7	93.3	9.33	5.17	.27	7.98	22.75	.069
Michigan Central	147.0	72.7	7.27	3.36	.26	5.33	16.22	.110	800.0	128.0	12.80	3.36	.26	5.33	21.75	.027
New York, Lake Erie and Western	132.4	85.0	8.50	5.32	.41	8.18	22.41	.169	545.0	122.4	12.24	5.32	.41	8.18	26.15	.048
New York, Pennsylvania and Ohio	137.2	70.0	7.00	4.17	.31	7.60	19.08	.139	477.5	117.9	11.79	4.17	.31	7.60	23.87	.05
Pennsylvania (Philadelphia to Pittsburgh)	133.6	67.5	6.75	5.28	.50	6.22	18.75	.140	609.25	136.0	13.60	5.28	.50	6.22	25.60	.042
" (Lines West of ")	142.8	58.87	5.88	4.96	.32	6.74	17.90	.125	596.75	100.3	10.03	4.96	.32	6.74	22.05	.037
Philadelphia and Erie	106.9	60.0	6.00	6.29	.38	6.16	18.83	.176	816.5	153.8	15.38	6.29	.38	6.16	28.21	.034
Averages	130.3	.....	.....	.....	.....	.....	18.47	.143	553.5	.....	.....	.....	.....	.....	23.34	.044

loads, the profits of the lines would be increased or their losses be diminished.

The report before us gives some data concerning the fuel consumption on the Indian railways, but it is difficult to get at their significance from the fact that the consumption on freight and passenger trains is not separated. The average consumption per train-mile—passenger and freight—on 14 lines was 41.67 lbs. of coal per mile. The "average" number of tons in a "goods train" on these roads was only 116.7 tons. Presumably this was the weight of the goods. This is only about a third of the weight of the freight in the average American trains given in Table V, published last month. On page 130 of the report the consumption of fuel "per 1,000 gross ton-miles" is given; but it is left in provoking uncertainty whether this means tons of freight or whether it includes the weight of cars or engines and tenders. The average consumption for 14 roads—excluding two which use wood for fuel—is 162.04 lbs. of coal per 1,000 gross ton-miles. If the weight of the engine and tender is included in the ton-miles, this consumption is high; if their weight is not included, it is low.

There are, however, other expenses besides the cost of fuel and repairs, attending locomotive service, in the transportation of freight and passengers, and which are dependent upon the efficiency of the locomotives. There is the cost of oil, waste, and other supplies, and the wages of enginemen and firemen, which are important items. It has been pointed out that the economy and the efficiency of locomotives are determined not by the fuel consumption alone, but by the total expenses which must be incurred to haul trains. These have been classified in Table II under the heads of Repairs, Oil Waste and Miscellaneous Supplies, and Wages of Enginemen, Firemen, and cost of Attendance and Cleaning. Evidently, too, in some kinds of traffic the relative cost of the wages of conductors and brakemen is affected by the capacity of the locomotives. Thus a train requires a conductor, and usually two, three, or four brakemen. Evidently if the engine pulls a heavy load this element of cost will be less, per ton of freight or per passenger, if many tons or passengers are hauled, than it would be if few are carried. For the present, however, we will take no account of this part of the expense, but confine what is said to those expenses which pertain directly to the locomotives.

As the cost of coal is a matter determined by local circumstances, and in order to make the conditions of the comparisons as nearly alike as possible, a common price of one mill, or one-tenth of a cent per pound, equal to $2.24 per ton, will be assumed for all roads. To arrive at the total cost of locomotive service of the 12 roads which report fuel consumption and train loads separately, we have tabulated the data contained in Tables II and III * in Table VIII, in which the cost of locomotive service is calculated per train mile and per ton of train per mile, at the same cost of coal—one mill per pound—for each road.

On this basis it will be seen in column 8 that the cost, including all the items given in the table, of locomotive service of passenger trains on the 12 American roads named is 18.47 cents, and from column 16 that of freight trains is 23.34 cents per mile. That of English trains, as shown in Table I,* including both passenger and goods, is 19.36; of Scottish, 14.66, and of Irish trains, 17.65 cents, the average being 18.72 cents. As the cost of traffic of British roads is not divided into passenger and freight expenses, it is not possible to compare the cost of these two classes of trains with that on American roads further than to observe that the cost per mile of passenger trains in this country is less than that of both classes of trains in

* Published in the November number of the JOURNAL.

England, and more than it is in Scotland or Ireland, and that the cost of locomotive service for freight trains is higher here than that of British freight and passenger trains. Without knowing the loads hauled, it is, of course, impossible to make any intelligent comparison of the cost of locomotive service. We have, however, calculated the cost per ton per mile, for both passenger and freight trains in this country, and, as shown by columns 9 and 17 of Table VIII, the average cost of locomotive service for passenger trains is .143 cents, and for freight .044 cents per ton per mile. As no data exists to show the weight of English trains, no comparison can be made on this basis.

From column 10 of the table it will be seen that the average weight of freight trains on the twelve roads included in the table was 553.5 tons. It is undoubtedly true that average English "goods" trains are not as heavy as the average of American freight trains given in the table; and it is safe to assume that the difference in weight is more than 25 per cent. The cost of locomotive service for American freight trains is 25 per cent. greater than that of all British trains. If the cost of goods trains in the United Kingdom is not less than that of passenger trains, then the cost of locomotive service per ton per mile of goods trains there must be greater than it is here. If the cost of such service for goods trains there is less than for passenger trains, then the cost for the latter must be more than 18.72 cents the average for all trains; and greater than the cost for such service on the 12 roads included in the above table. It follows then that unless the passenger trains on British roads are considerably heavier than on the lines given in the table, that the cost of locomotive service for such trains there must be considerably more than it is here. The average weight of all passenger trains on the 12 American roads given was 130.3 tons. Is the average weight of passenger trains on English, Scotch and Irish roads more or less than this?

It follows from this that unless the average weight of passenger trains is greater on British roads than it is on the American lines, of which we give reports, that the cost of locomotive service per ton per mile must be greater there than it is here. In this deduction there is some doubt about one of the premises—that is, with reference to the items of expense included under the head of "cost of working," of British engines. *The Engineer* should, however, be able to enlighten us with reference to this point, and, we hope, give some data concerning the average weight of trains on English roads. To again quote, or rather paraphrase, its own language against itself—"if our cotemporary cannot obtain them, on what grounds does it claim to represent English railways?"

The conclusion to be drawn from the data in Table VI is, that the average cost of locomotive service on American roads is only .143 cents per ton per mile for passenger trains, and .044 cents for freight trains; and that we do not know certainly what it costs on British roads, but there is a very strong presumption that, estimated on the same basis, it is considerably higher there than it is here.

An exact comparison is possible, however, if we compare Mr. Buchanan's trials with those made on the North British Railway, as the weights of the trains are given in both reports, and, as already mentioned, the average results are summarized in Table VII.* The value of the coal at one mill per pound for each road, the cost of repairs on each road, of oil, etc., on the New York Central, wages of engineers and firemen on both are all given. These expenses are added up for each road, and the sums are given in column 16, from which it will be seen that the total cost per train mile of locomotive service on the North British road is 17.63 cents, whereas on the New York Central it was 21.96. Each of these sums has been divided by the weight of the cars in the trains—given in column 6—and the result is given in column 17, from which it appears that the total cost of locomotive service per ton of train per mile was on the Scotch road .075 cents, whereas on the New York Central it was only .018 cents, or *less than one-quarter as much* as on the North British line.

But the comparison does not end here. As we have taken occasion to point out before, the total cost of locomotive service not only includes the cost of fuel, repairs, oil, etc., and wages of engineers and firemen, but in certain kinds of traffic the relative cost of the wages of conductors and brakemen, if apportioned per ton of freight carried per mile, is very much influenced by the train loads hauled. In Table VII the wages of conductors and brakemen on the New York Central have been given in column 18, and added to the total cost of locomotive service. The sum will be found in column 19. Dividing this total cost per mile for locomotive and train service by the weight of the train gives the total cost per ton per mile, which is given in column 20.

The same items were added to the North British expenses, excepting that it was assumed that for its shorter trains only two brakemen would be needed instead of three on the New York Central. Estimated in this way, it will be seen from column 20 that the cost of locomotive and train service in the North British trial per ton per mile was .096 cents, whereas on the American road it was only .023. In other words, *it was more than four times as great on the Scotch road than it was in the American trials.*

During the year 1890 the Pennsylvania Railroad lines east of Pittsburgh carried nearly 7,000,000,000 tons of freight one mile. If the locomotive expenses and cost of train services had been as great relatively to the tonnage hauled on this line as it was on the Scotch road, the expenses of the Pennsylvania company would have been increased over $5,000,000. These surely are weighty facts, which may, in part, account for the average freight rate on British roads being 1¼*d.* = 2½ cents per ton per mile, whereas here, on our through lines, it is a very little over one-half a cent.

It will be noticed in column 9 of Table VIII that the proportion of the weight of the North British engine to that of train hauled was as 1 to 6, and that the American engine pulled 22.6 times its own weight.

Now it may be that the experiments quoted by *The Engineer*, which were made in 1876-77, do not fairly represent the best English practice in the transportation of freight—and we doubt whether they do—but they are the best that are available for purposes of comparison and were quoted by our esteemed disputant, and it remains for him to either admit that they do not represent such practice, or if they do not to quote data which do. His failure to do either would be a virtual concession of the superior economy of American freight engines. The discussion of this subject will be concluded in our next issue.

(TO BE CONTINUED.)

* Published in the last number of the JOURNAL.

THE TRANSANDINE RAILROAD.

Album of Views of the Transandine Railway. Published for the Contractors.

This series of views contains 29 fine photographs taken on the line of the Transandine Railway, and includes some of the best views of mountain scenery we have ever seen. They illustrate very well the difficulties met in building the railroad, and show the rugged and picturesque scenery of the higher Andes. These views are accompanied by a description of the road.

The Transandine Railway is designed to connect Mendoza, the most westerly point reached by the Argentine railroad system, with Santa Rosa, the terminus of a Chilean line, among the foot-hills of the Andes; thereby completing the only transcontinental line in South America, and the only railroad from the Atlantic to the Pacific south of the Panama Railroad. The distance by rail from Buenos Aires to Valparaiso is 850 miles, and the gap to be filled by the new line was 150 miles. Of this the 110 miles from Mendoza to the Chilean line is owned by the Buenos Aires & Valparaiso Transandine Railway Company, and the 40 miles from the boundary line to Santa Rosa in Chile is known as Clark's Transandine Railway, the intention being to consolidate the two when completed. The enterprise owes its success so far to Don Juan and Don Mateo Clark, who obtained the original concessions, and have actively pushed the work. The line passes over the Uspallata Pass and the summit is 10,600 ft. above the sea. In this respect there is a considerable advantage over the two railroads which have thus far been carried over the Andes further north—the Lima & Oroya in Peru and the Antofogasta in Chile—both of which reach an altitude of 15,600 ft.

Numerous and careful surveys were made for the road, and in the final location the line was considerably shortened by the adoption of the Abt rack-rail system for several short sections, where grades of 12½ per cent. will be used.

Early in the present year the railroad on the Argentine side had been completed from Mendoza to Rio Blanco, 75 miles, while a further section of 12 miles, to Punta de las Vacas is nearly ready, leaving only 23 miles to be built. On the Chilean side it is finished from Santa Rosa eastward 23 miles, leaving 17 miles still to be completed. The 40 miles unfinished include the great summit tunnels, and extensive preparations have been made for the work. It is intended to utilize the water-power of the mountain streams, power being transmitted from the water-wheels to the points where it will be needed by electricity. The tunneling can be carried on from several different points, and will be all in hard rock, requiring no lining.

At present work is almost suspended, owing to the financial disturbances in the Argentine Republic and the revolution in Chile, but it is hoped that it will soon be actively resumed. A condensed description of the line is given as follows:

Leaving Mendoza at an elevation of 2,376 ft. above the sea, the line passes through vineyards and cultivated ground for 13 miles to the first station, Blanco Encalada. At the 15th mile the first important bridge is passed, a viaduct of six spans of 60 ft. each; it is not, however, until the Boca del Rio is reached at mile 19, that the railroad actually enters the gorge formed by the River Mendoza, and begins the ascent of the Andes. Here the very heavy work commences; after entering the gorge by a series of deep cuttings and a short tunnel, the line again crosses the Mendoza by a bridge of 148 ft., and before the 30th mile has been reached the river has been crossed five times by bridges of various spans from 148 to 246 ft. After passing the Paramillos Plain a tunnel is entered, followed at the 34th mile by another bridge of 246 ft. span; between this point and Uspallata station several tunnels have been pierced and the river has to be crossed again three times, twice by bridges of 246 ft., and once by a span of 197 ft. In addition to these heavy works there are many smaller bridges crossing the streams which flow down the side valleys of the Mendoza. Although the river is crossed so frequently, a number of tunnels and deep cuts were unavoidable, owing to the numerous spurs of the mountains. Bearing in mind that there was no road over which the heavy bridge girders could be carted, it is satisfactory that the line has been opened in so short a time from the commencement of the work in 1887.

From Uspallata to Punta de las Vacas the works are less difficult. They have been completed ready for traffic as far as Rio Blanco, and good progress has been made with the earthworks as far as Punta de las Vacas. Between Rio Blanco and the summit tunnels the first length of rack-rail has been introduced.

On the Argentine side there are four tunnels close to the summit, having a total length of 13,743 ft., and during the eight months preceding the stoppage of work last autumn the headings had been driven for a length of 5,628 ft., leaving 8,115 ft. of heading to be done; very satisfactory progress for eight months, half of which were winter months, when less work can be done.

On the Chilean side there will be five tunnels, the total length of which amounts to 36,630 ft., of which 3,846 ft. of heading have been driven during seven months, by hand labor only.

It will thus be seen that on the Chilean side out of a total length of 40 miles 23 are completed, and of the remaining 17 miles more than 7 miles are in tunnel.

The Transandine Railroad has an advantage over the two railroads already mentioned, which cross the Andes further north, in having a comparatively short section through unproductive territory. The Antofogasta Railroad is without local traffic for nearly 300 miles, and depends upon through business entirely, yet the results so far are satisfactory. The Lima & Oroya line has absolutely no local business after entering the mountains, and its sole dependence is the traffic of the Cerro di Pasco mines.

On the line of the Transandine there is already a large business in cattle, which are driven over the Uspallata Pass with much difficulty. There is also some passenger travel over the pass, which will be very largely increased when the road is finished, as the only competition will be with the steamers running between Buenos Aires and Valparaiso by the Straits of Magellan, a stormy and difficult passage which now takes about 12 days. Trains will be able to run through in less than two days. The traffic in general freight, now carried by steamer, is also considerable.

The Transandine is an important and notable line, and when completed it may fairly claim to be one of the great railroads of the world. It is to be hoped that the Messrs. Clark will soon be able to announce the full resumption of work.

NEW PUBLICATIONS.

PROFESSIONAL PAPERS OF THE CORPS OF ROYAL ENGINEERS. VOLUME XVI, 1890. Published by the Royal Engineers' Institute, Chatham.

The contents of this volume are about equally divided between matter of a purely military character and that which pertains to the domain of the civil engineer. Lieutenant-Colonel Saville discusses the question of the use of the cycle in future military operations, and gives some extraordinary examples of long distance riding. Mounted Infantry in Modern Warfare is discussed by Lieutenant-Colonel Hutton; and Captain Orde Browne brings down the record of Guns *vs.* Armor to the beginning of the present year. To the military reader the diagrams of English Service Ordnance are of particular interest. In a series of plates are given diagrams, drawn to scale, of the field, siege, garrison, machine and quick-firing guns in the English service, with their carriages and mounts, and so fully illustrated that the absence of descriptive text is scarcely noted.

Among articles of a more general interest is one on Bridges in the Bengal Presidency, by Sir Bradford Leslie. The presence of great rivers subject to extraordinary floods and of a soil thoroughly alluvial surround railroad, and especially bridge construction in India, with difficulties elsewhere unknown. The writer gives many interesting details of the devices resorted to for the protection of railroad bridges and embankments from the effects of a sudden and enormous rise in the waters. He

draws a graphic picture of the hand-to-hand struggle of the engineer with the annual inundations which sweep over the low-lying districts, when often the most untiring vigilance is powerless to prevent widespread destruction of railroad property, while the great heat and the presence of "cobras and other vermin" in the drift add greatly to his troubles at such times.

The paper on Road Making, by Mr. Percy Boulnois, is one we should like to place in the hands of every road engineer and county commissioner in the United States. The painstaking care given to the construction of even country roads in England and on the Continent would put to shame the slipshod way in which much of the city pavement is put down in this country. One acquainted with the country roads in some of the most prosperous parts of New York, Pennsylvania or Ohio—and they are often wretched makeshifts—may well wonder what the state of the country might be if this author's declaration be true that "the condition of the roads and streets of a community is the principal sign of its prosperity or otherwise."

COAL AND COAL CONSUMPTION IN SPANISH AMERICA. *Reports from the Consuls of the United States in Answer to a Circular from the Department of State.* Government Printing Office, Washington.

In this pamphlet the State Department has collected a number of consular reports from Central and South America and the West Indies on the fuel consumption and resources of different countries. It may be said that, with the exception of Chile and a few small mines in Mexico, no coal is mined throughout all the region named; some coal deposits are known to exist in Venezuela and elsewhere, but the stage of profitable working has not been reached. This lack of cheap fuel is the chief hindrance to the development of manufactures in most of the South American States. The United States ought to supply them with a large part of the fuel they need; and there is a possibility of the growth of a great coal trade. The information collected by the State Department will be of service to those who may be interested in building up such a trade.

SIXTH ANNUAL REPORT OF THE COMMISSIONER OF LABOR: COST OF PRODUCTION OF IRON, STEEL, COAL, ETC. Government Printing Office, Washington.

This report presents the results of an investigation made by the Bureau of Labor under the charge of Commissioner Carroll D. Wright into the relative cost of producing iron and steel and mining coal and iron ore in the United States, as compared with other countries. Mr. Wright's work is usually faithfully and intelligently done, and in this report he presents a great mass of information on the points indicated. The results are not in every case what might have been expected, but the comparisons are, in almost every case, full of interest. The investigation is not limited to the cost alone, but includes many particulars as to the condition of laborers, their earnings, cost of living and other similar matters.

The only objection to be made to the report is that its size prevents the careful study which one would like to make of it. The three volumes include 1,404 pages, and an attempt at a careful inspection gives one an idea of the amount of labor needed to collect and prepare the information.

THE ENGINE RUNNER'S CATECHISM. A SEQUEL TO THE STEAM-ENGINE CATECHISM. By Robert Grimshaw, M.E. John Wiley & Sons, New York; price, $2.

This book is intended as a guide to those who have to run stationary engines; it is, as the author says, intended to "treat more of special builds of engines as erected, adjusted and run, than of the properties of steam, or the general principles of engine design and construction."

It includes descriptions of a number of well-known types of stationary engines, with directions for setting, adjusting and running them, and also some general directions which are applicable to all engines. The descriptions and directions seem generally clear and plain, and the book should be a useful one. It is of small size, so that it can conveniently be carried in the pocket and kept ready for reference at any time. There is some good advice about foundations and the setting of engines. While there is little that is new, there is much that it is very convenient to have in a compact and accessible form.

TRAP SIPHONAGE AND TRAP-SEAL PROTECTION. By Professor J. E. Denton, M.E. The American Health Association, Concord, N. H.

This pamphlet is reprinted from the *Transactions* of the American Public Health Association, and contains a detailed account of an extended series of experiments in trap siphonage conducted, under Professor Denton's direction, at the Stevens Institute of Technology. These tests were intended to determine the relative capacity and degree of reliability of the several methods of preserving the trap-seal now known in plumbing practice. The results given are of much interest to architects, engineers, and all who have to do with building and sanitary arrangements. They should receive careful study.

SELECTED UNITED STATES PATENTS OWNED OR CONTROLLED BY THE THOMSON-HOUSTON ELECTRIC COMPANY, THE BRUSH ELECTRIC COMPANY AND ALLIED CORPORATIONS. The Thomson-Houston Company, Boston.

Some idea of the number of patents issued for electrical appliances may be obtained from the fact that this volume of 396 pages contains only those controlled by one corporation. With only a very brief introduction, the book gives the drawings and specifications in the form issued by the Patent Office. It contains altogether 81 of these specifications, the earliest in date being No. 217,677, issued to C. F. Brush, July 22, 1879, for a dynamo-electric machine. They cover numerous appliances of all kinds for dynamos, electric motors, electric railroads and other work of the kind. The book will be of service to electricians for reference.

THE PRACTICAL CATECHISM. *A Collection of Questions on Technical Subjects, and of the Answers Thereto.* By Robert Grimshaw, M.E., Ph.D. John Wiley & Sons, New York; price, $1.25.

This is simply a collection of notes made in answer to questions put to the author by many correspondents, and on a variety of subjects so great as almost to defy classification. Some 50 general topics are named in the index, ranging from Air, Alloys, Beams, through the alphabet to Waters, Weights, Wines, Work. It is fortunately accompanied by a complete index, so that the reader can find any particular topic about which he may be looking for information.

It is one of those miscellaneous collections which could hardly be criticised without going through every page carefully. The most that can be said is that the matter is arranged with some care, and that it can hardly fail to contain much information which is likely to be useful to a busy man. He may find what he wants in a condensed form, and so save himself the trouble of hunting it up from various sources. In this way the book will be found worth having and keeping for reference, while it will not supersede the use of other works.

TWENTY-SECOND ANNUAL REPORT OF THE STATE BOARD OF HEALTH OF MASSACHUSETTS. State Printers, Boston.

This report contains a general statement of the work done under the direction of the Board during the past year, and

several special reports on various topics, such as the Health of Towns, Growth of Children, Food Inspection, etc., etc The larger part of the volume is occupied by reports on Water Supply and Sewerage, and their relations to the public health. These are in continuation of the work already done in the issue of the valuable reports on Water Supply heretofore issued by the Board, and referred to in our columns from time to time.

DIE UHRMACHERKUNST UND DIE BEHANDLUNG DER PRÄCISIONS-UHREN (WATCHMAKING AND THE MANAGEMENT OF CHRONOMETERS). By Eugene Gelcich. A. Hartleben, Vienna.

This bulky volume of 640 pages, with 249 engravings, gives a complete account of the watchmaker's art, and is based on theory as well as practice, giving reasons for its directions and carefully worked-out formulas wherever they are applicable. Lack of familiarity with the details of watchmaking prevents a close criticism, which could only be intelligently made by one thoroughly acquainted with the art; but it may be said that the book is apparently thorough and carefully written. The chapters on the care of chronometers, stop-watches and what may be called time-keepers of precision, would doubtless be of interest to navigating officers of ships and others who have the care of such watches.

TABLES INCLUDING THE MOST FREQUENTLY USED VALUES OF NUMBERS. By Dr. H. Zimmerman. Ernst & Korn, Berlin, Germany.

In this German work Dr. Zimmerman has tabulated for the use of those who have to make calculations, the product of each number up to 999 by each number from 1 to 100; the square and cube of each number; the square root and cube root of each number; the reciprocal and the logarithm of each; the circumference and the area of a circle having each number for its diameter. There are also supplemental tables giving factors and natural logarithms.

These tables will doubtless save much time for those who have long and complicated calculations to make.

TRADE CATALOGUES.

The Uses of Mineral Wool in Architecture, Car-building and Steam Engineering. The United States Mineral Wool Company, New York.

This pamphlet contains an account of mineral wool, showing what it is, how it is made and the uses to which it may be put, with some directions for its application in cars, buildings, etc. This material is now in extensive use for covering boilers and steam pipes, filling in the spaces between the outside and inside sheathing of cars and buildings and for other similar purposes, and its excellent qualities are leading continually to its still more general use.

The term "wool" conveys to most people an idea of an animal substance, but mineral wool is "essentially a vitreous substance converted to a fibrous condition." It is made by converting scoria and certain rocks while in a molten condition into a fibrous state. The process is peculiar, and is covered by patents held by the company named above. The fibers are soft, pliant and elastic, like those of wool, but the substance in mass is incombustible, and is a non-conductor of heat; it is these properties which give it value, and they are fully explained in the pamphlet.

Pencils: the Joseph Dixon Crucible Company, Jersey City, N. J.

A circular very attractive to the editorial mind is issued by the Joseph Dixon Crucible Company in the shape of a bundle of excellent pencils of various grades. This company does not praise its own manufactures; it is quite willing to stand by the results of a trial of them.

The Florida Vestibule Limited. Passenger Department of the East Tennessee, Virginia & Georgia Railroad, B. W. Wrenn, General Passenger Agent.

The neatest and most tasteful railroad card we have ever seen is the time-card of the "Cincinnati & Florida Limited," issued by General Passenger Agent B. W. Wrenn, of the East Tennessee, Virginia & Georgia Railroad. Its design and execution are admirable, and it inspires one with a wish to travel over the line which sends out such a tempting invitation.

Tools: Illustrated Catalogue and Price List of Hammacher, Schlemmer & Company, New York.

BOOKS RECEIVED.

Annual Report of the Chief of the Bureau of Steam Engineering, Navy Department, for the Year 1891: *George W. Melville, Engineer-in-Chief, U. S. N., Chief of Bureau.* Government Printing Office, Washington.

Bulletins of the United States Geological Survey. Nos. 62, 65, 67–81, *inclusive.* Government Printing Office, Washington. These include some very valuable papers, notably No. 73 on the Viscosity of Solids; No. 74, on the Minerals of North Carolina; No. 75, Record of North American Geology, 1887–89; No. 79, on a late Volcanic Eruption in California; though there are others deserving especial mention.

Report of the Chief of the Bureau of Ordnance, Navy Department, for the Year 1891: *Commander William M. Folger, U. S. N., Chief of Bureau.* Government Printing Office, Washington.

Case School of Applied Science, Cleveland, O.: Catalogue for the Scholastic Year, 1891–92. Published by the School, Cleveland, O.

Reports of the Consuls of the United States to the Department of State: No. 132, *September,* 1891. Government Printing Office, Washington.

Report of the Commissioner of Railroads of the State of Michigan for the Year 1891: *Charles R. Whitman, Commissioner.* State Printers, Lansing, Mich.

Quarterly Report of the Chief of the Bureau of Statistics, Treasury Department, Relative to the Imports, Exports, Immigration and Navigation of the United States for the Three Months ending June 30, 1891. Government Printing Office, Washington.

Annual Report of the Chief of the Bureau of Statistics, Treasury Department, on the Foreign Commerce of the United States for the Year ending June 30, 1891. Government Printing Office, Washington.

Annual Report of the Commissioner of Patents for the Year 1890. Government Printing Office, Washington.

World's Columbian Exposition, Chicago. Classification of Department of Transportation Exhibits: Railroads, Vessels, Vehicles. Willard A. Smith, Chief of Department. Issued by the Commission, Chicago.

Annals of the Society of Italian Engineers and Architects: No. 4, *Volume VI, August,* 1891. Published by the Society, Rome, Italy.

Colorado State Agricultural College, Experiment Station: Bulletin No. 13, *The Measurement and Division of Water. Bulletin No.* 16, *The Artesian Wells of Colorado and their Relation to Irrigation.* State Agricultural College, Fort Collins, Col.

The Eleventh Census. By Robert P. Porter, Superintendent. This is a reprint of an address delivered by Mr. Porter before the American Statistical Association in Boston in October last.

Royale Universita Romana, Scuola d'applicazione per gl' Ingegneri: Annuario per l'Anno Scolastico, 1891–92. Published by the Royal University, Rome, Italy.

The Philadelphia Record Almanac for 1892. The *Record* Publishing Company, Philadelphia.

ABOUT BOOKS AND PERIODICALS.

We are requested by Mr. Robert Grimshaw to state that he is preparing a Record of Scientific Progress in 1891, which will be published by Cassells & Company, and that he would be much pleased to receive, from those who have done or who know of any noteworthy scientific work during the year, some particulars of the same. His address is No. 21 Park Row, New York.

In Harper's Weekly for December 9 there is a picture of the new Reading station in Philadelphia, which was illustrated and described in the Journal for December. In the number for December 16 there is a four-page plate showing the buildings for the Columbian Exposition in Chicago, with an accompanying description.

The January number of Scribner's Magazine begins the sixth year of that periodical. The articles include one on Bokhara and Central Asia; one on American Illustration, and a very interesting paper on Crime and the Law, by Recorder Smyth, of New York.

In the Eclectic Magazine for December there will be found, as usual, a number of selections from the best English magazines and reviews. One of the articles which will attract attention is the last number of Mr. Murray's papers on Australia.

The January number of the Popular Science Monthly has another part of the article on American Pottery. Mr. D. A. Wells writes of Some Remarkable Bowlders, and Mr. Carroll D. Wright has an interesting study of Our Population and its Distribution. This number has an unusual number of illustrations.

The Arena begins the new year with a number as free and aggressive as usual, and full of material for thinking people. The January number is fully up to the usual high standard in quality.

Among the articles in the Journal of the American Society of Naval Engineers for November are papers by members on Fan Blowers; the Centrifugal Pump; some New Alloys; and Speed Curves of Ships building for the Navy. There are also abstracts and translations of several valuable foreign papers.

The number of Harper's Magazine for January is one of unusual excellence, and contains a number of articles that will repay reading. This is the oldest of the monthlies, but shows no signs of age in its columns.

Besides the usual variety of stories and sketches, the Overland Monthly for December has articles on the Defenses of the Pacific Coast; on the Dead Blue River and other lost rivers of California; on the Santa Barbara Islands, and on Flower and Seed Growing, an industry of considerable importance on the Pacific Coast. This magazine has made a very great improvement lately in the number and quality of its illustrations, and the December number has some excellent engravings. The January number is also to have some excellent illustrations.

Among the books in preparation by John Wiley & Sons, New York, is the Manual of Experimental Engineering, by Professor R. C. Carpenter, of Cornell University.

The January number of Outing has illustrated articles on a variety of winter sports, with some excellent sketches and a few stories. Winter Photography is a paper which will interest many readers. The military article for the month is on the Active Militia of Canada; in it the author treats of the Northern Lake Forces.

In the Compass for December the article on Series of Numbers is continued, and there are also articles on the Pantograph, on the Plain Transit and on Speedy Calculators.

In Goldthwaite's Geographical Magazine for December there are articles on the Trade Winds; the Unexplored Regions of Canada; Self-Purification of Rivers; Trans-Siberian Railroad Routes, and a number of shorter ones of much interest. This magazine is of wider scope than its special title would indicate, and almost any intelligent reader will find in it something to interest him.

It may interest some of our readers to know that Government publications, if they cannot be secured through some member of Congress, can usually be bought at a fixed price from J. M. Hickox, 905 M Street, W., Washington. The same party issues a monthly catalogue of all Government publications, which can be obtained by subscribing.

AN OLD-TIME FAST LOCOMOTIVE.

The illustration given herewith is a reproduction of an early Talbotype, which was, we are informed, taken in 1848, and which represents a locomotive built at the Norris Works for the Camden & Amboy Railroad. We have not the exact dimensions of this remarkable engine, nor the date when it was built, but believe that the cylinders were 13 in. × 38 in. and the driving-wheels 8 ft. in diameter. The general design is shown by the engraving; the forward end of the engine was carried on a six-wheeled truck, and the single pair of drivers was placed back of the fire-box. This arrangement required a peculiar position of the cab, which was placed very high, and was apparently built without much regard for symmetry or appearance. In fact, it looks somewhat like a switchman's or watchman's house transferred from the side of the track to the top of the boiler. The same lack of symmetry may be seen in the smoke-stack, which was of singularly clumsy pattern. The engine probably burned wood, which was the general fuel for locomotives at that time. The valve-motion was all outside, and was the old V-hook motion; apparently there was an independent cut-off valve, working on the back of the main valve, a not uncommon arrangement.

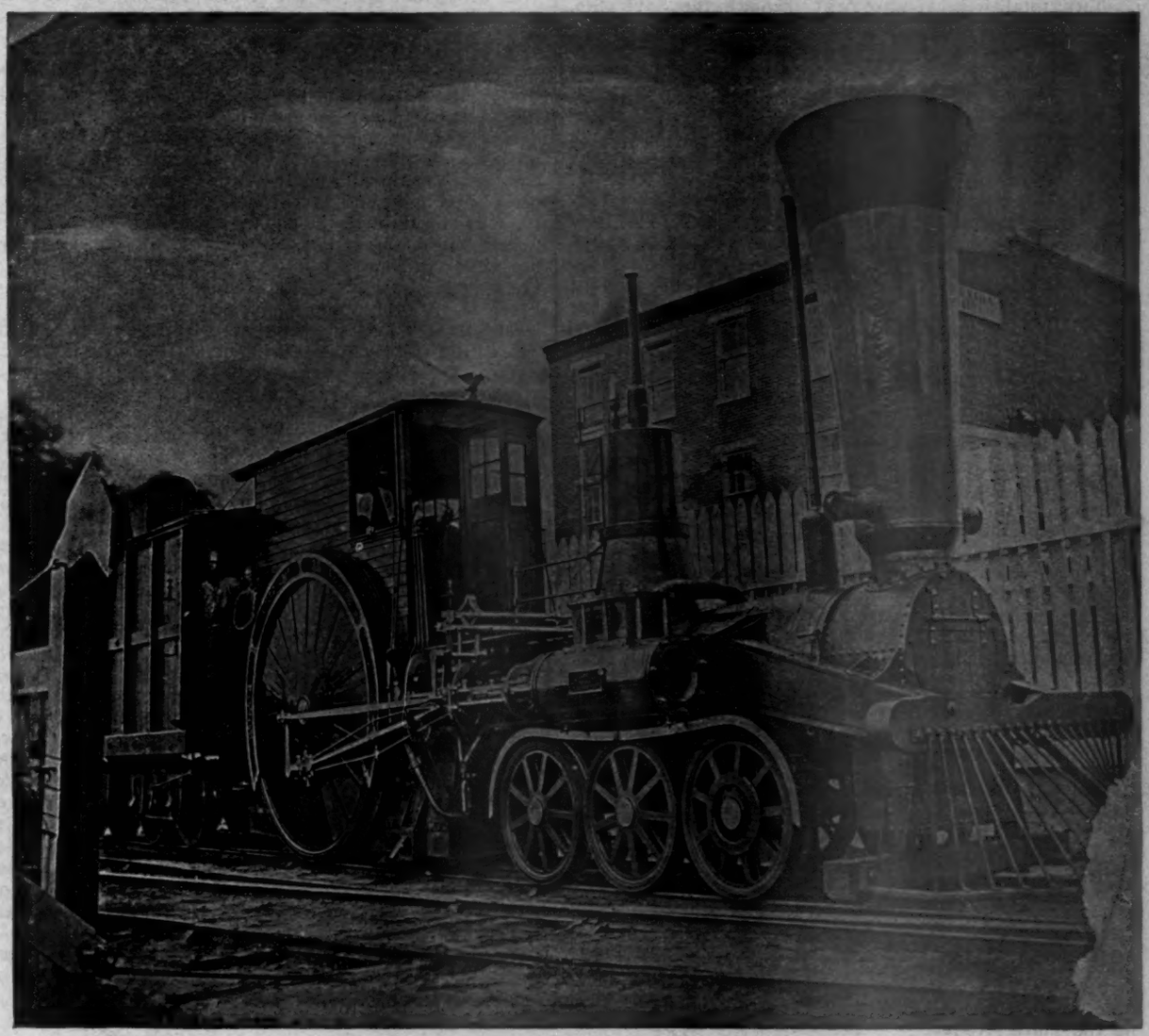
Some of the peculiar features shown did not belong to this engine alone. The spaces between the spokes of the driving-wheels were filled in with wood, an arrangement which was in use on many of the locomotives of the Camden & Amboy Railroad for a number of years. The trussing of the connecting-rod was also practised on that road for a long time, and there were locomotives running with side-rods trussed in the same way as late as 1873. The high dome could also be found in quite a number of engines on the same road. The covered tender, somewhat resembling a small box car, was the pattern in general use on the road, and survived up to 1865 or thereabouts; it was provided with a sort of hood or buggy-top on the back end, in which sat a man whose duties were to watch over the train and signal the engineer when anything was wrong, the bell-cord passing through his seat.

We do not know what became of this particular engine, nor do we know whether there are surviving records of any fast runs made by it. Some other engines of the same kind were built a little later, either at the Trenton Locomotive Works or at the Bordentown shops. These were of a little better appearance, and a more modern type; some of them had 13 × 38-in. and some 14 × 38-in. cylinders and 7-ft. or 7 ft. 6-in. drivers. The writer has been told by old engineers on the road that they did some fast running, but had so little weight on the drivers that they could not handle a heavy train; moreover they had an

unpleasant tendency to jump the track on the sharp curves which abounded on the old line, which followed the canal bank between Trenton and New Brunswick, and which was abandoned when the present line from Dean's Pond to Trenton was built, about 1863. These later engines were afterward rebuilt with four drivers of smaller diameter, about 5 ft., one pair placed in front and one behind the fire-box, according to the usual pattern. The long-stroke cylinders were retained, however, and four or five of these engines with 38-in. stroke were in service for some time after the New Jersey lines were leased to the Pennsylvania Railroad Company. These engines had larger boilers than the one shown in the engraving, and had iron frames instead of the wooden frames which appear in the original Norris type.

It would be interesting to know whether any drawings of this old engine survive, or whether they have disappeared with the records of its performance. The managers of the Camden & Amboy were rather given to experiments in locomotives, and the old shops at Bordentown would have furnished material for an interesting study had full records of the work done there been preserved.

The photograph from which the engraving was made was taken by Schreiber & Sons, of Philadelphia, from the original Talbotype. This original has been well preserved during the 43 years since it was taken, the only defect being the blur on the lower right-hand corner of the plate, which has wiped out a part of the pilot.



A FAST LOCOMOTIVE OF FORTY YEARS AGO.

SOME CURRENT NOTES.

In relation to the article on a Bit of Locomotive History, published in the JOURNAL for September last, a subscriber, Mr. A. A. Maver, of Stratford, Ont., writes us that his Father, who ran the locomotive *Earl of Airlie* for some years, on the Dundee & Newtyle Railway early in the forties, recognized the engraving of that engine as a picture of an old frjend, adding, however, that it would have seemed more natural had there been a small truck behind with a water-barrel on it, for such was the tender used in those days. He also says that the *Trotter*, which was referred to in the article, was not the same as the *Earl of Airlie*. That engine had the driving-wheels in front, as shown in the engraving, but the upright cylinders of the *Trotter* were placed alongside of the smoke-box and the driving-wheels back by the fire-box, which gave a much longer connecting-rod.

On December 1, 1891, according to the tables of the *American Manufacturer*, there were in blast furnaces having a total capacity of 193,009 tons of pig iron weekly, an increase of 6 per cent. over the same period in 1890. Iron production showed a steady increase through the whole of the latter half of 1891, a result which did not agree with many expert predictions.

It is stated that the orders placed up to December 8 for

steel rails for 1893 delivery amounted to 600,000. This indicates an improvement over 1891, and a prospect for better business than last year.

THE iron ore shipments from the Lake Superior region for the season of 1891 were 6,490,205 tons, showing a decrease of 19½ per cent. from those of 1890. These shipments were well taken up by the furnaces, only a little over 1 per cent. of the total being reported as in stock unsold at the receiving ports.

THE total freight movement through the Sault Ste. Marie Canal for the season of 1891 was 8,888,759 tons, which is 1½ per cent. only below that of 1890; a remarkable result when the falling off in iron ore shipments is considered.

THE result of the biddings for mail service under the Postal Subsidy Act of last year has been hardly what the advocates of the law anticipated. The few contracts let have been for third and fourth-class service, with one exception, and nearly all cover existing lines. The only contract for the second-class is also for a new line, and is for service from New York to Buenos Aires and Montevideo, once in three weeks; it is not to begin until December, 1894. No contract for first-class service has been let under the act.

THE tables of the English *Lloyd's Register* show that there were added to the world's mercantile fleet last year 1,362 vessels, with a total tonnage of 1,646,809 tons. Of these 482 ships of 318,268 tons were sailing vessels, and 880 ships of 1,328,541 tons were steamers. In sailing vessels the United States built 28 per cent. of the total tonnage, but in steamships only 6½ per cent. As to material, 780 of the ships were of steel, 145 of iron, 14 composite and 423 of wood.

It is notable that for several yeast past there has been a steady increase in the number of wooden vessels and of sailing vessels built, a reaction in favor of wood having apparently set in. On the other hand, steel has almost entirely superseded iron as a ship-building material.

THE business of the elevated roads in New York showed last year an increase of about 5 per cent. only; the figures from the Manhattan Company's report for the year ending September 30 are:

	1891.	1890.
cond Avenue line	32,574,091	33,479,216
enue line	77,978,822	73,258,192
xth Avenue line	69,254,641	62,907,323
Ninth Avenue line	19,520,387	18,559,146
Total	199,327,941	188,203,877

There was an actual falling off on the Second Avenue line, but this was probably due to the fact that the Suburban Elevated which at first connected only with that line, was last year extended so as to transfer passengers to the Third Avenue.

Elevated road growth does not seem to have hurt the surface lines, for the Third Avenue Road last year carried 35,000,000 passengers—the largest number ever noted.

THE Khojak Tunnel, the completion of which has recently been announced, is one of the great tunnels of the world. It carries the Indian Frontier Railroad under the summit of the Khojak Pass in the Himalaya Mountains, and is 12,600 ft. long. The workings were carried on from both ends and from two intermediate shafts, and have been chiefly in hard rock, the greatest delays coming from seams full of water, met with from time to time.

The Frontier Railroad is a Government work, and is built entirely for military reasons. It extends from the terminus of the Indian railroad system at Quetta to Candahar, and its object is to aid in supporting English influence in Afghanistan, and perhaps also to prepare for the time when an English army at Kabool will have to face a Russian force from Merv with the Trans-Caspian Railroad at its back.

THE report of the Chief of Engineers in relation to coast defense states that the sums appropriated last year have been used chiefly in providing casemates and other sites for heavy guns at New York, Boston and San Francisco, the guns for which are under construction by the Ordnance Department. Plans have been prepared for fortifications for Portland, Philadelphia, Washington, Charleston and Hampton Roads, and for the extension of those at New York and San Francisco. The casemates or batteries now under construction do not include any of the proposed iron or steel protected works, but are generally of concrete covered with sand, and the use of disappearing carriages has generally been kept in view in designing batteries.

AMONG the other work which the Navy has had in hand during the year is the work of extending surveys for the inside channel along the Atlantic seaboard. The general design which has been considered by the Navy Department in preparing its part of the scheme for coast defense has been the opening of the Cape Cod Canal, so that torpedo-boats and gun-boats of moderate draft could proceed from Boston through the canal along Long Island Sound, thence by existing canals, the Delaware River and Chesapeake Bay to Hampton Roads, then by the Albemarle & Chesapeake Canal and the sounds along the coast of Florida. It would be possible to secure a channel with at least 8 ft. of water for the whole distance with comparatively little work, and the value of such an interior waterway in case of war can easily be estimated; while at the same time its formation would be of very great benefit to commerce. In addition to this, it is proposed to improve the channels along the New Jersey coast, so that vessels might be able to proceed from Cape May to Atlantic City, and from thence to the head of Barnegat Bay, without obstruction.

THE problem of generating electricity direct from heat, without the intervention of the steam-engine and dynamo, has occupied the attention of electricians for some time, and now Mr. Edison has, according to the *Safety Valve*, so far succeeded that he has applied for a patent for his invention, giving the following general description: "The object I have in view is to generate electricity directly from carbon, coal, or other carbonaceous material, without the loss caused by the indirect method heretofore employed of converting the same into a motive power, from which electricity is produced by mechanical motion. This I accomplish by employing carbon or carbonaceous material for the generating or soluble electrode of a generating cell and in using therewith as an active agent oxides, salts or compounds of elements, by the decomposition of which the carbon or carbonaceous material will be acted upon at high temperatures. The cell is constructed and adapted for the application of heat externally thereto, and the conducting or negative electrode of the cell is made of a substance which in the presence of carbon at high temperatures is not attacked to any great extent by the active agent employed."

A CORRECTION.

AMONG the Current Notes in the November number of the JOURNAL (page 489) was the following:

Since the article in the October number of the JOURNAL (page 455), on the increased strength obtained by oil-tempering and annealing steel forgings, was published, we have received particulars of another test. In this case a steel crank-pin was taken, the chemical analysis being as follows: Carbon, 0.050; manganese, 0.060; silicon, 0.150; phosphorus, 0.035 A specimen ½ in. in diameter and 2 in. between marks, cut longitudinally from the pin, after treatment stood the following tests: Tensile strength, 112,040 lbs.; elastic limit, 61,170 lbs.; elongation, 20.55 per cent.; contraction of area, 45.53 per cent. These are notable results

In some unaccountable way the decimal points in the chemical analysis of the steel given above were misplaced, and it ought to read as follows: Carbon, 0.50; manganese, 0.60; the silicon and phosphorus being correctly given. This statement will make the item intelligible.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

CHEMISTRY APPLIED TO RAILROADS.
XXIV.—STEEL FOR SPRINGS.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

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(*Continued from page* 554, *Vol. LXV.*)

The question of what kind of steel to use in springs, both spiral and elliptical, or flat bar springs, is one that has received a good deal of study in both the Laboratory and in the Mechanical Engineering Department of the Pennsylvania Railroad Company. The necessity for this study will become apparent when it is stated that ten years ago it was not at all uncommon to have a pile of broken sprial springs, removed from freight cars at the important places where repairs are made, large enough to load four or five cars. Indeed, it seemed as though it was the general rule that the springs would break after a few months' service rather than that they would continue in service for a long period of time. This applied especially to the bolster and draw-bar springs of freight cars. The elliptical or flat bar springs, both on cars and locomotives, have never given anything like the trouble; but even in these two kinds of service, the difficulties have been sufficient to warrant a good deal of attention to the subject.

It may be interesting to state that on careful examination and testing by well-known formulas derived from Reuleaux's work on this subject, it was found that the design and metal used in the spiral springs on the Pennsylvania Railroad from eight to ten years ago was of such a kind that the metal was actually strained in certain forms of springs even beyond its tensile strength, when the spring was brought down solid. It will doubtless be remembered that the form of spring most commonly in use ten years ago was an oval bar coiled on its edge; and the strain in the metal of many of these springs, figured by Reuleaux's formulas, showed that when the spring was brought down solid, in almost all cases the elastic limit of the metal was exceeded, and in many cases the actual tensile strength of the metal was exceeded. It was no wonder, therefore, that the springs broke in service, since, in addition to holding up the load, which may be called the static strain in the metal, there are likewise, as is well known, in actual service many strains introduced into the spring which cannot be calculated, due to side thrust on striking a curve, owing to the elevation of the outer rail on a curve, and to inequalities in the track.

In view of the state of affairs above described, very careful study some eight or ten years ago was put upon the question of the kind of steel to be used in springs, and also upon the question of design. The form in which the metal should be put, and the weight of the steel used, together with the detail drawings and the different kinds of spiral springs ultimately decided upon, will, it is hoped, be treated later on. This article will be confined especially to the quality of the steel; and it will be sufficient to say, in regard to the design, that, as is well known, it was ultimately decided to use in spiral springs only round bars, and that the design only strains the metal 80,000 lbs. per square inch when the spring is brought down solid. As a preliminary to deciding upon both the design and chemistry of the steel, or, in other words, what kind of steel shall be used; quite a large number of round and flat bars of specified chemical composition were obtained from two or three of the most reliable spring steel makers. One half of these bars were tempered and the other half were annealed, and the whole lot was then sent to the big Government testing machine at Watertown Arsenal to be broken and the physical properties carefully obtained. Following this came an analysis of the steel, and upon this data—namely, the results of physical test obtained from the large testing machine and from the analyses of the samples—the specifications were drawn up.

In the service there are three uses of steel for springs: first, *spiral* or *helical* springs, mostly used on freight cars, and also used somewhat on passenger cars, cabin cars, and maintenance of way cars, and in various places throughout the service; second, *double elliptical* springs, most largely used on passenger cars, and also in other parts of the service as occasion may require; third, *half elliptical* springs, used on locomotives. Definite chemical specifications have been prepared for the steel used in all kinds of spiral springs, and for the steel used in locomotive springs. No chemical specifications have yet been prepared for the double elliptical springs used under cars. Up to the present time this kind of springs has been bought from the best makers, and as the laboratory is in constant consultation with these people, it is pretty well understood what metal is used. It seems probable that definite specifications may be prepared at no distant day for the steel used in this class of springs also. The chemical specifications for locomotive spring steel are as follows:

PENNSYLVANIA RAILROAD COMPANY.

Motive Power Department.

SPECIFICATIONS FOR LOCOMOTIVE SPRING STEEL.

Steel for locomotive springs must be delivered in sizes and lots as ordered, and each bar when received must be free from physical defects, including cracks along the edges and seams, and must stand the operation of being cut into proper lengths cold, by the ordinary process of nicking and breaking over the edge of the anvil.

Bars which vary more than (0.01) one one-hundredth of an inch in thickness, or more than (0.02) two one-hundredths in width from the size ordered, or which break where they are not nicked, or which when properly nicked and held, fail to break square across where they are nicked, will be returned and must be replaced free of charge.

The metal desired has the following composition: Carbon, 1.00 per cent.; manganese, 0.25 per cent.; phosphorus—not over 0.03 per cent.; silicon—not over 0.15 per cent.; sulphur—not over 0.03 per cent.; copper—not over 0.03 per cent.

Shipments will not be accepted which show on analysis less than 0.90 or over 1.10 per cent. of carbon, or over 0.50 per cent. of manganese, 0.05 per cent. of phosphorus, 0.25 per cent. of silicon, 0.05 of sulphur, and 0.05 of copper.

Theodore N. Ely,
General Superintendent Motive Power.

Office of General Superintendent Motive Power, Altoona, Pa., August 1, 1887.

It will be observed that these specifications cover the questions of variations from size, as well as the chemistry of the metal. It will also be observed that there is no special physical test for this kind of metal. The chemistry of the metal and the size of the bars, together with the breaking over the anvil, are all the tests made. In regard to breaking over the anvil, it may be said in explanation that the bars are received in lengths too long, of course, for use, and that it is customary to cut them up into leaves by nicking them and breaking them over the anvil. It sometimes happens that the steel is so irregular that the break is not square across the nick, and sometimes also a piece will break 2 in. away from the nick rather than at the nick. This is of rare occurrence, but is always regarded as evincing lack of uniformity in the metal, possibly due to irregular heating or working too cold, resulting in over-tempering, or due to too rapid cooling by throwing the bars into water or allowing the rain or snow to fall on them after they are finished. Of course if a bar breaks in this way there is considerable lost metal, and the specifications are drawn to cover this point.

It is believed that these are the only possible specifications for this kind of steel, since, as is well known, steels containing as much carbon as is required above are more or less inclined to take temper according to the temperature at which they are passed through the rolls the last time, and also in proportion to the rate of cooling, so that

steel entirely uniform in composition might show very wide variation in physical test, depending on the temper, and the physical specification would therefore have to be of such wide limits, unless perchance special annealing of the test pieces should be made use of, that the physical test would be of very little value. On the other hand, since we always heat this steel, and always temper it before it goes into service, the actual condition of the steel as received from the manufacturers as evinced by the physical test would be of very little value to us. Accordingly the quality of the steel is measured wholly by its chemistry.

As is customary in our specifications, it will be noted that a pattern analysis is given, and that this is followed by the limits on which rejection will take place.

Taking up now the items in detail; it will be observed that we desire 1.00 per cent. carbon in our spring steel, and that if the amount is less than 0.90 or above 1.10 per cent. we reject. At first we thought to give simply a lower limit in carbon, but we soon found that we received metal as high as 1.25 per cent. and sometimes as high as 1.30 per cent. carbon, and of course steel so high in carbon would not, under the same treatment in the shop, both in working under the hammer and also in tempering, give uniform results. We were compelled, accordingly, to limit the amount of carbon. There is no data in our possession to show that we could not use with perfect success a steel running, say, from 1.10 to 1.20 per cent., or 1.15 to 1.25 per cent. carbon; but we do think it essential to have certain limits, both upper and lower, in order that there may be enough uniformity in the metal, so that the shops will be able to turn out uniform work. The question of the amount of carbon in spring steel has been the subject of a great deal of controversy. We are well aware that the carbon we require is much higher than is the practice in Europe, and, indeed, much higher than most of the spring-makers were using at the time these specifications were adopted. Some of the large steel manufacturers remonstrated with us over these limits, and, indeed, were quite certain that a serious mistake had been made in placing the limit of carbon so high. An experience now of some five or six years with these limits of carbon in springs has apparently confirmed the wisdom of the choice, as will be set forth a little later in speaking of spiral springs.

It may not be amiss to mention here, in regard to the limit of carbon in steel for springs, that special attention was given to this subject by one of us during a trip to Europe in 1886. It was found that the general European practice seemed to be about 0.70 to 0.75 per cent. carbon in spring steel. On several occasions those in charge of large spring establishments were asked why they used steel so low in carbon, since it was quite evident that the strength of the metal was increased and a smaller amount of metal would hold up the load if higher carbon steel were used. The reply was that the manufacturers were making steel to sell, and were not studying the subject in the interest of the railroad companies. In confirmation of this point it will doubtless be remembered by those who have given the matter attention, that the customary thickness of a leaf in flat bar springs in Europe is from $\frac{1}{2}$ to $\frac{5}{8}$ in., while in this country $\frac{3}{8}$ in. is rarely exceeded in thickness. It seems as though there could be little doubt as to which is the wiser practice; and as far as our experience has gone, we have seen no occasion to regret placing the carbon as high as is given in the above specifications.

The question of the manganese in steel for springs has likewise been the subject of considerable controversy. The manufacturers, when these specifications were issued, were divided. Those who were anxious to make steel for springs by the crucible process wanted us to place the limit not above 0.20 or 0.25 per cent., so as to keep out steel made by the open-hearth or Bessemer process. On the other hand, those who were interested in the open-hearth or Bessemer process, and in a few cases the crucible people, wanted a higher limit of manganese, on the ground that it would be impossible to make spring steel so high in carbon in the open-hearth furnace if the manganese was as low as 0.20 or 0.25 per cent. The crucible people, who wanted high manganese, thought a better metal could be obtained by allowing the manganese to run as high as 0.60 or 0.70 per cent. In view of this conflicting data, it was decided—possibly a little arbitrarily—to make the limit 0.50 per cent.; and nothing has arisen thus far in the service to indicate that this limit was a seriously objectionable one. We are quite well aware that a good many open-hearth people think that a much better limit would be 0.60 per cent. manganese, and we really know of no reason why such a limit should not be allowed. It is claimed by these people that they are a little more certain of getting solid ingots if the maganese runs as high as 0.60 per cent. We are having and have had no difficulty in securing a steel which does not exceed the limits of manganese mentioned, and apparently the manufacturers have learned to meet the requirements without any serious trouble.

The question of phosphorus has likewise been the subject of some controversy and difficulty. It is well known that in the market to-day the phosphorus is the element which practically fixes the price. A material which will make a steel containing not over 0.03 per cent. phosphorus is easily worth $5 per ton more than a material which will make a steel containing 0.08 per cent. phosphorus, and as competition naturally drives down prices, the tendency is to use a steel containing the higher amount of phosphorus. We have spent considerable time and study over the question of phosphorus in steel for springs, and are frank to say we do not know where the safe limit is. Some of the steel manufacturers think our limits in locomotive spring steel are full high even now. Others are inclined to think we could go still higher with safety. Within the last two years we have made careful analyses of some 20 broken spiral springs taken from the service to see whether any relation could be discovered between the breakage and the phosphorus, since it is well known that the common influence of phosphorus is to render the steel brittle, especially when the carbon is high. These 20 analyses showed nothing practical. About one-half the broken springs were even below 0.05 per cent phosphorus, some of them as low as 0.03 or 0.035 per cent., while the other half were between 0.05 and 0.09 per cent. It will be obvious, with a little thought, that the chemistry of the metal is not the only cause for the breakage of springs. The design of course has a very important influence, and also the temper. It is hoped and believed that our design of spiral springs is perfectly satisfactory, but we had no means of measuring the temper of these broken springs, which were analyzed as above stated, and consequently we were in doubt as to whether the breakage was due to over-temper or high phosphorus. It seems clear that in part of the cases it must have been due to over-temper. In the others it may have been assisted, or possibly may have been due wholly, to the high phosphorus. The question therefore still remains unsettled, and we do not know what the safe limit of phosphorus is. The tendency in spiral springs is toward an increase in the use of phosphorus, and it is probable that sooner or later we will be able to say what the safe limit is. More recent analyses of the phosphorus in spiral springs indicate that we are commonly getting steel containing as high as 0.06 or 0.08 per cent. of phosphorus.

With regard to the silicon and sulphur, we are inclined to think that high silicon is to be avoided as much as possible, on account of the fact that the material is worked by blacksmiths in a fire, and, as is well known, silicon oxidizes much more rapidly than iron in a fire. In other words, our experience indicates that the silicon is more important in the working of the metal in the fire than anywhere else, and the rather high limit which we have given—namely, 0.25 per cent., was introduced only to allow crucible steel to still come in, since, as is well known, it is impossible to make steel in the crucible without having somewhere from 0.15 to 0.25 per cent. silicon. If the steel could be made successfully by both the open-hearth and crucible processes, we would prefer a steel containing not over 0.05 per cent. silicon in steel for springs.

No positive relation has been discovered so far as we know between the sulphur and the value of the steel for springs. We are inclined to use as low sulphur as we can get, and the limit was placed with this idea in mind.

The same remarks apply to a certain extent with regard to the copper in steel. We do not know what the safe limit of copper is, and the limit placed is more of an arbitrary one than one based on positive knowledge. We have some experiments in progress on this point, and hope to have some definite information within six months or a year as to the actual influence of copper on spring steel. Until that information can be obtained, we of course keep the copper as low as we can.

The first specifications for locomotive spring steel were issued not quite four years ago, and they have not yet been revised. They have worked with very great satisfaction; and the difficulties in shop manipulation have been less, we are confident, than before the specifications were adopted. It is natural that this should be so, since a uniform product has been furnished the shops.

The chemical specification for the steel to be used in making spiral springs is as follows:

Manufacturers must furnish for chemical test one extra spring for every 500 or fraction thereof of Classes A, U, V, W, X and Y springs shipped, and one extra spring for every 300 or fraction thereof of all other classes shipped. These springs for chemical test will be chosen by the Inspector at random from the lot ready for shipment, and he will use his discretion as to taking samples to represent the fractions of above numbers. Each sample for chemical test will, however, represent a definite number of springs shipped, and the shipment will be accepted or rejected on this sample. The metal desired for springs is steel of the following composition: Carbon, 1.00 per cent.; phosphorus, not over 0.05 per cent.; silicon, not over 0.10 per cent.; manganese, 0.25 per cent.; and sulphur, not over 0.03 per cent. Springs will not be accepted which show on analysis less than 0.90 per cent. of carbon, or more than 0.50 per cent. of manganese.

It will be observed that the springs are divided into classes, according to the letters of the alphabet. The characteristic of each class and the mechanical engineering details will appear, it is hoped, later. At present the same kind of steel is used in all spiral springs, and this kind is specified in the description above. It is fair to state that for all springs in which the size of the bar is not over ½ in. in diameter, no chemical specifications are enforced, as it has been found by long experience that the kind of steel used is not an essential to their successful working. In other words, these springs are so designed that almost anything in the shape of steel will do the work required of them, and as their use is not enormous, it was deemed advisable not to enforce chemical specifications for this class of springs.

Turning now especially to the chemistry of the steel, it will be observed that the metal asked for is as good as in the case of the locomotive springs, but that the only requirements which are enforced are the carbon and manganese contents. This may seem a little strange, but we think the following explanation will make the matter clear.

Our position is that for steel where no physical test is possible, the chemistry of the steel shall be complete, and decides the quality. In cases where physical test is possible, and where a physical test can be made cheaper or with less difficulty than a chemical analysis, there use the physical test alone. In some cases the results desired can only be obtained by a combination of these, and this is the case with spiral springs. A physical test bringing the springs down solid is all the physical test that is practicable in the case of spiral springs, but this test does not show whether the elastic limit in the metal used is not just about reached when the springs are brought down solid, a state of affairs which is not desirable. In other words, it is fairly probable that a metal with 0.75 per cent. carbon pretty well tempered would have an elastic limit of about 80,000 lbs., so that if only a physical test of bringing the spring down solid was made use of, we might be getting springs in which the actual strain in the metal was up to the elastic limit of the metal, with no margin for extra strains introduced by the contingencies of the service. This point we think is thoroughly covered by the chemistry of the steel—namely, even an untempered steel of the carbon and manganese required by our specifications has an elastic limit pretty nearly or quite up to 80,000 lbs. But such a steel will not stand at the required height with a given load, and perchance would take a permanent set when brought down solid, therefore it is essential to temper it somewhat, which raises the elastic limit, and gives us the factor of safety required.

The query may arise why other substances besides the carbon and manganese are not determined. The reason for this is as follows: If a spring has the amount of carbon and manganese specified, and the phosphorus is high, with the amount of temper required in order to make it stand at the proper height with the specified load, or not take permanent set, that spring will break under physical test. In other words, the phosphorus, silicon and sulphur are fairly well controlled by the physical test, provided the carbon and manganese are as specified. This was the reasoning made use of when the specifications were issued, and the experience of now some six or eight years seems to confirm the reasoning. In other words, if you control the carbon and manganese you can safely trust the physical test to protect you against receiving steel too high in the other objectionable constituents.

It will be observed that there is no upper limit to the carbon in steel for spiral springs, and the reason for this is that excessive carbon is likewise protected by the physical test. We do no work on these springs after they are received, and it is not essential that the carbon should be within certain limits. If the manufacturers are willing to put into these springs a steel containing 1.25 per cent. carbon, we are perfectly willing to receive them, provided they stand the physical test. The same reasoning in regard to the manganese applies in the case of this steel, as in the case of the steel for locomotive springs.

The working of these specifications has been in every sense satisfactory. The breakage of spiral springs in service has almost entirely disappeared. After some 30,000 of the bolster and draft springs had been put in service, a count was made to see how many of the springs, according to the new specifications, had been removed for breakage at one of the most important shops for car repairs, and less than five were found. Also it is fair to say that to one of the largest shops on the road some two years ago a request was sent to have every broken spiral spring, according to specifications, removed from freight cars, sent to the laboratory until 20 were found, and it took over a month to get this number.

There are still some problems not worked out in regard to spiral springs—namely, the question as to whether, under continued service, the springs will take a permanent set; and second, the question as to whether or not it is going to be essential to establish a limit of phosphorus, and indeed to go into the chemistry of the steel more completely than simply the carbon and the manganese. Upon the first of these two points it is fair to say that one considerable measurement of springs in service has been made, which resulted practically in showing that there was no appreciable permanent set to the springs which had been longest in service. Also recently the physical test has been made a little more severe—namely, all important springs are now brought down solid before they are sent from the works.

The question of phosphorus has been fairly well discussed in the early part of this paper, but arrangements have been made by which all springs which have been brought down solid under physical test and which broke or took a permanent set in service are to be sent to the laboratory until some more light is thrown on this subject.

As has already been stated, the breakage of spiral springs in service has very largely disappeared. Also it may be stated that the breakage of elliptical springs under cars is a very rare occurrence. The breakage of locomotive springs is more frequent, and recently an investigation has been started, to see if it was possible to locate the cause of the difficulty. There seem to be four possible reasons why a locomotive spring may break: *First*, bad steel; *second*, bad design; *third*, bad shop manipulation in the manufacture; and *fourth*, the use of springs designed for a certain track on very much rougher track.

Each of these items will bear a word. The question of the quality of the steel has been very carefully gone over

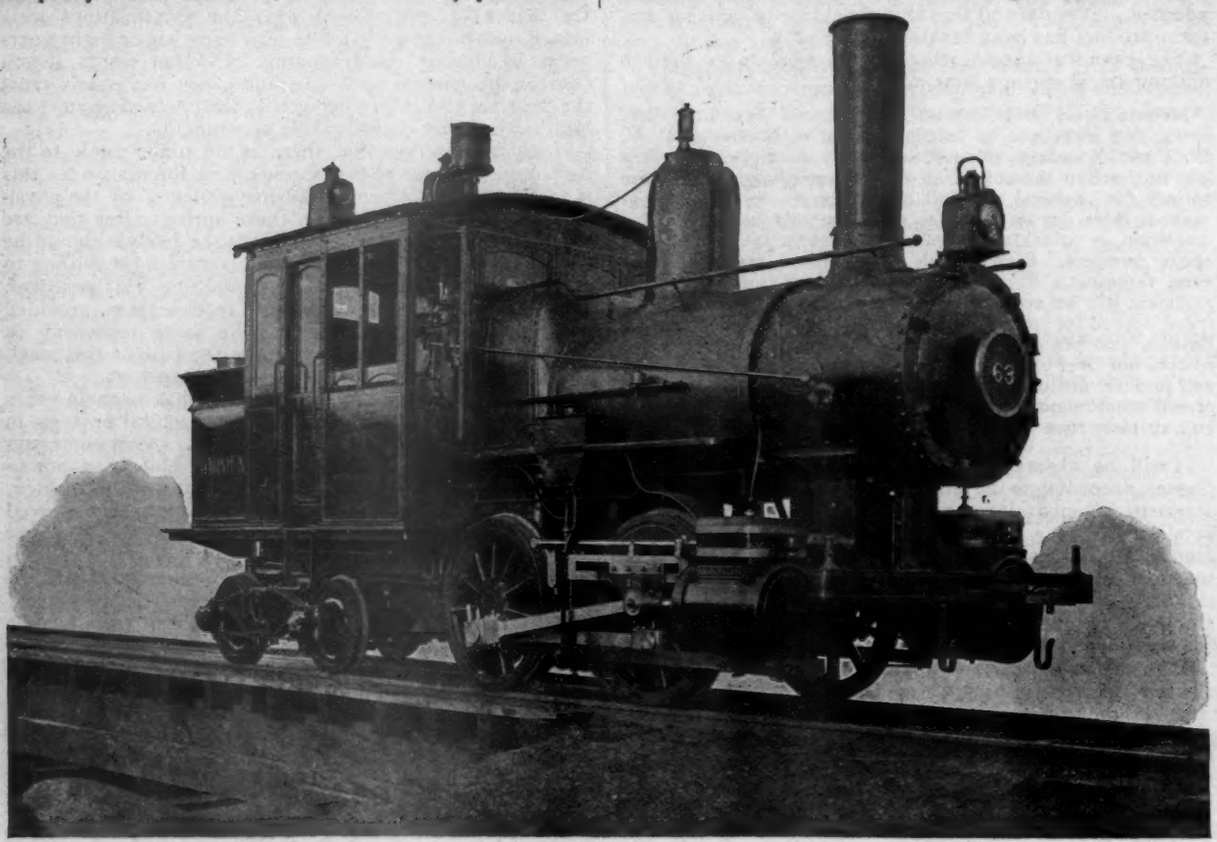
recently. Some 25 analyses of broken locomotive springs have been made. The result of this study shows that the steel in the locomotive springs which have broken is as good steel as we can get in the market, it having conformed to almost all the requirements given above for locomotive spring steel. We concluded from this work that the cause of the difficulty did not lay in the quality of the steel used. The second reason—namely, the design, is still under advisement, and it is possible some modifications of design may be necessary. This part of the study is not yet quite complete; but in view of the fact that the laws governing the use of metal in such structures as springs are pretty well worked out, it seems entirely possible to check up the design sufficiently well so that it will be safe to say that the difficulty is not with the design. If these two questions are satisfactorily settled, it would seem as though the difficulty with breakage must be either in the shop manipulation or in the fourth cause mentioned. Under the head of shop manipulation we refer to the danger of over-tempering or the over or under-heating of the steel, or other abuse of it by the blacksmiths making the springs. We have been accustomed to think that possibly considerable of the difficulty may lie here; but it has been recently suggested that there was a fourth cause—namely, the attempt to use a spring designed for a certain kind of track on a much rougher track. It should be stated that if the springs as designed are too strong, there is complaint that the engines ride roughly. On the other hand, if they are too weak as designed, so as to ride easier, and then are run at high speeds over a bad section of track, they receive shocks much more severe than they were designed to sustain, and consequently the leaves break. This point has not yet been fully worked out. All mechanical engineers are of course quite familiar with the fact that they are at all times in a strait betwixt two extremes, and that this applies to springs as well as to other parts of construction. To put it briefly, if the spring is designed to stand a rough track, it will ride very hard when it gets on smooth track, and where to draw the line is the great difficulty.

We hope to give the next article on bearing metal, and this will possibly be followed by one or two more.

(TO BE CONTINUED.)

A COMPOUND ELEVATED LOCOMOTIVE.

THE accompanying illustration is from a photograph of a compound locomotive built by the Rhode Island Locomotive Works in Providence for the Brooklyn Elevated Railroad. As will be seen from the engraving, it is of the Forney type, with four drivers and a four-wheeled truck under the tank, which is carried on an extension of the frames.



COMPOUND LOCOMOTIVE FOR ELEVATED RAILROAD SERVICE.

BUILT BY THE RHODE ISLAND LOCOMOTIVE WORKS, PROVIDENCE, R. I.

The boiler is 44 in. diameter of barrel, and has 170 tubes 1½ in. in diameter and 6 ft. 3½ in. long. The fire-box is of the Belpaire pattern, the crown-sheet being supported by radial stays. The fire-box is 58 in. long and 42½ in. wide.

The driving-wheels are 42 in. in diameter, and are spaced 5 ft. between centers. The total wheel-base is 16 ft. 1 in. The truck is a swing-motion truck, with four 26-in. wheels. The tank will hold 600 galls., and the weight in working order is 54,500 lbs., of which 37,500 lbs. are on the drivers.

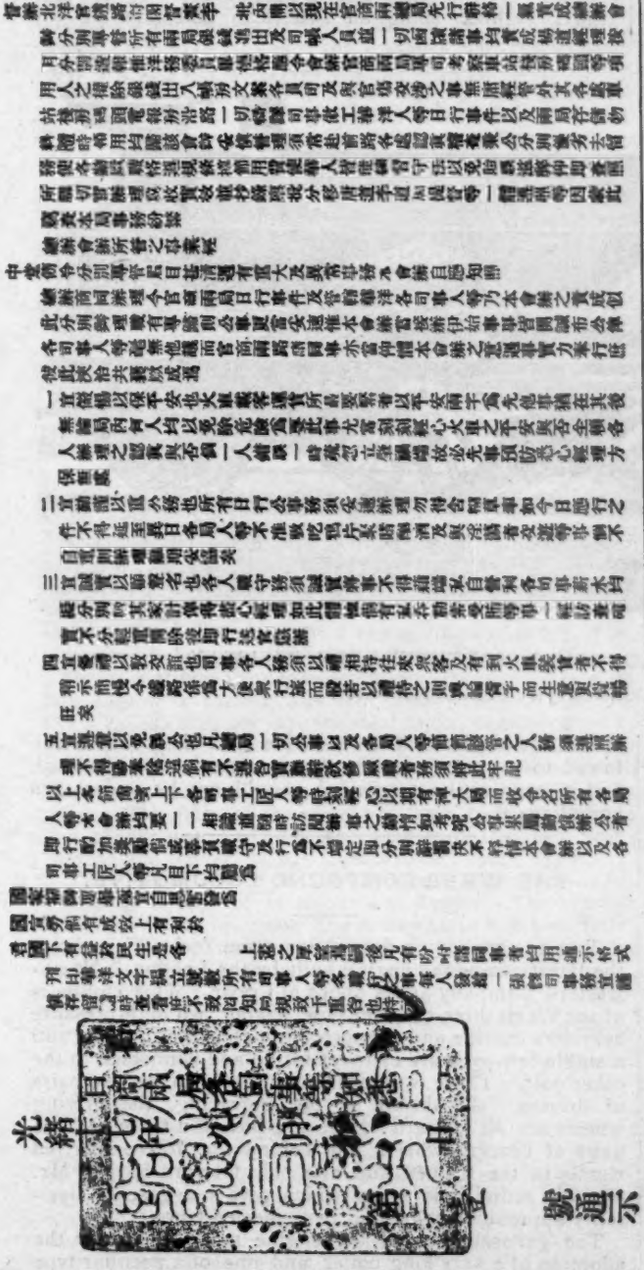
The engine is a two-cylinder compound, with the intercepting valve used by the Rhode Island Works. The high-pressure cylinder is 12½ in. in diameter and 16 in. stroke; the low-pressure 20 in. in diameter and 16 in. stroke, the ratio of the two cylinders being 1 : 2.56. The valve motion is of the ordinary shifting-link type.

Some particulars of a trial of an engine of this class were published in the JOURNAL for January, 1891; and elsewhere will be found some statements of comparative trials of a compound locomotive from the same works, in general passenger service.

CHINESE RAILROADS.

LATE advices from Tientsin state that by the direction of the Viceroy the Imperial Chinese Railway and the China Railway Company have been consolidated, and the management has been entrusted to Yang Hung-Tien Taotai as Managing Director. He will have charge of the finances and official matters.

The position of Assistant Managing Director has been given to Mr. W. N. Pethick, who will have charge of the



GENERAL ORDER NO. 1, IMPERIAL CHINESE RAILROAD.

operation of the road, and is practically the General Manager. Mr. Pethick is a New Yorker, who served in our Army during the War; he is a practical railroad man and has been in China long enough to understand the country and the people well.

We give herewith a reduced copy of the first general order issued under the new management; for the order we are indebted to General James H. Wilson. For the benefit of those of our readers who do not understand Chinese, we append a translation, as follows:

IMPERIAL CHINESE RAILWAYS.

GENERAL ORDER NO. 1, 1891.

Notification from the Assistant Managing Director on taking charge of the working staff of the Imperial Chinese Railway and China Railway Company.

MANAGING DIRECTOR'S OFFICE,
TIENTSIN, October 10, 1891.

To all employés of the Imperial Chinese Railway and China Railway Company:

On October 9, 1891, I had the honor to receive the following instructions from His Excellency, the Grand Secretary and Viceroy Li, Director-General of Imperial Railways:

"It is hereby ordered that the head offices of the Imperial Railway and the China Railway Company be now consolidated and placed under a Managing Director and an Assistant Managing Director, whose responsibilities shall be divided as follows:

"Receipts and disbursements of money, employés in the finance department, and Chinese official correspondence and accounts, to be in charge of Yang Taotai, who shall prepare monthly statements of the accounts.

"Mr. W. N. Pethick, of my Foreign Staff, is appointed Assistant Managing Director of both lines, with full charge of the working staff at the stations, storehouses, wharves, etc. He is not to be concerned with finances, finance staff, secretaries' staff or relations with Chinese officials. He is to have control over stations, godowns, wharves, telegraph offices, and all interpreters, assistants, and workmen, both native and foreign, in the ordinary course of business. All stores of materials for both lines and their issue as required shall likewise be in his charge. He will be required to frequently visit the stations, etc., and keep careful oversight of them; he is to act justly in employing or discharging people as they may deserve, and see that every employé faithfully performs his duties, obeys rules, and practices economy; and he is to be careful that native employés are properly trained and disciplined, so that mistakes and malpractices may be prevented.

"Let those concerned carry out these orders thoroughly, and so justify hope for substantial improvement in the service.

"Copies of this order will be sent to T'ang Taotai, Li Taotai, and General Chou for their guidance."

The respective functions of the Managing Director and the Assistant Managing Director are now clearly defined; and it will be my duty to report to the Managing Director any business of unusual importance.

My special responsibility is the entire control of the working staff and of the ordinary routine business of the whole line. This has been made by my superiors a separate department in order that one man may deal promptly with the numerous matters affecting the staff constantly requiring attention.

On assuming these duties I desire to make known to all employés of both lines the plan I intend to follow, and the assistance I shall expect from every one, so that there may be a clear understanding and perfect accord between us.

1. CAUTION.—The most important of all things is safety of life and property carried on the line. Everything else is subordinate to this, and the first care of every employé must be to prevent danger. On railways, the safety of all depends on the faithfulness of every man in the service; the fault of one may cause great disaster. To obtain safety it is necessary that every one should exercise caution and forethought, and faithfully perform all his duties.

2. DILIGENCE.—Duties must be performed promptly and thoroughly. What should be done to-day must not be put off until to-morrow. Opium smoking, gambling, carousing and associating with dissolute or idle people are prohibited. No one can do his work well without exercising self-respect.

3. HONESTY.—Strict honesty must be observed in all business. No one must take advantage of his position to seek private gain. It is intended to pay all employés adequate salaries, so that there will be no excuse for peculation, extortion or bribery. Any one found guilty of dishonest practices will be immediately discharged and handed over to the authorities for punishment.

4. COURTESY.—This must be exercised at all times, and especially toward the public who make use of the railway. No

passenger or shipper must be treated rudely or taken advantage of in any way. The railway is for the public convenience, and the good-will of the public will be obtained by courteous treatment.

5. OBEDIENCE.—Orders and instructions given by those in authority must be obeyed promptly and fully. Disobedience of orders will not be excused in any one. This must be carefully remembered by all who wish to remain in the service.

I ask all employés, high or low, to give heed to these matters, and thus contribute to the success and good repute of the service. I shall take pains to know personally every member of the service, and how he performs his duties. I shall take pleasure in rewarding those who exert themselves, and will certainly dismiss or have otherwise punished those unworthy of confidence. Bad conduct or neglect of duty will not be overlooked. All should reflect that they are serving the country in an important new enterprise which will benefit Government and people if successful. If each does his duty success will be certain.

I would also ask you to remember at all times the importance of exercising courtesy and forbearance in dealing with the natives. There is often much to provoke or exasperate, but on no account should violence be used toward them, save only in defense of life. Nor should violent or abusive language be used. Adequate punishment for real offenses will be found in discharging or fining the offender, or suspending him from duty; and if more severe punishment is deserved, it can be administered in due form of law by the local official having jurisdiction. It is always possible to exercise firmness or do justice with show of violence. Nothing causes us loss of prestige more than a habit of giving way to angry passions.

Being in China, I do not expect to take part in any rapid transformation scenes. Reform and improvement will have to work their way gradually, but I hope none the less surely and thoroughly.

In future instructions to the staff will be issued in the form of General Orders, printed in Chinese and English, and numbered consecutively. A copy will be sent to every employé concerned, and such orders must be carefully preserved and frequently read—no one who has disobeyed an order need then plead ignorance of it.

W. N. PETHICK,
Assistant Managing Director.

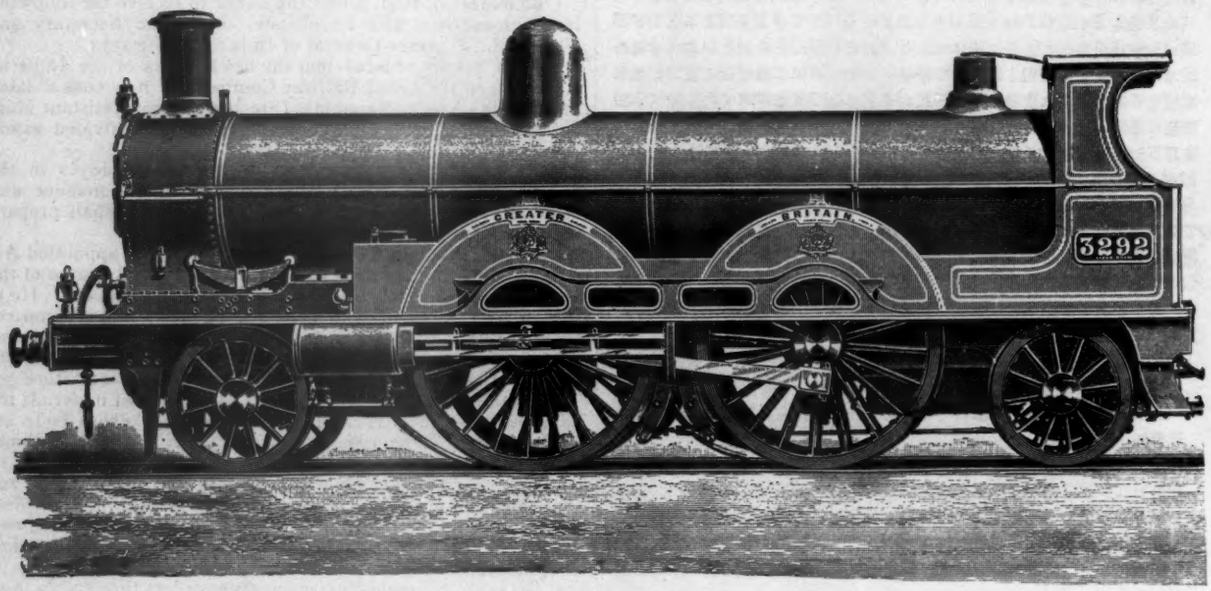
This order seems to be addressed chiefly to the Chinese employés, and is a sort of primary instruction or condensed elementary treatise on their duties. At the same time Mr. Pethick issued the following circular, which is especially addressed to the members of the foreign staff; the headings, etc., are omitted, giving only the substance of the order:

GENTLEMEN: Having been appointed by H. E. the Viceroy to the position of Assistant Managing Director, with control of the Working Staff and the ordinary business of both lines, I beg to inform you that I shall give special attention to measures for facilitating the prompt and efficient transaction of public business, and shall be glad to make such changes as may be for the good of the service.

To this end I trust that I may count on your co-operation. H. E., the Viceroy, having determined to give foreign management a fair trial, the duty devolves upon all of us to do what we can to justify this expression of confidence in foreign integrity and business methods; for it is the system more than the individual that will be on trial.

I particularly invite your attention to the first great essential of success—safety of life and property on the line. There are many factors in this problem; and I shall always be glad to receive and carefully consider practical suggestions bearing on any branch of the subject.

Mr. Pethick being an American and familiar with American methods, it is probable that they will be followed to a great extent in the management of the road, and in building its extensions, should any be undertaken hereafter.



COMPOUND EXPRESS LOCOMOTIVE, LONDON & NORTHWESTERN RAILWAY.

DESIGNED BY F. W. WEBB, LOCOMOTIVE SUPERINTENDENT.

THE WEBB COMPOUND LOCOMOTIVE.

THE accompanying illustration, from *Industries*, shows the latest compound engine built by the London & Northwestern Company at its shops at Crewe. This engine is of the Webb three-cylinder type, having two high-pressure cylinders outside and connected to one pair of drivers, and a single low-pressure cylinder inside and connected to the other pair. There is no connection between the two pairs of drivers. As shown by the engraving, the driving wheels are all forward of the fire-box, and there are two pairs of bearing wheels, one behind the fire-box carried rigidly in the frames, and one pair forward having Mr. Webb's radial axle-boxes, which give a degree of flexibility approaching that of a two-wheeled truck.

The general plan of the engine made necessary the adoption of a very long boiler, and one of a peculiar type has been used. An intermediate combustion chamber is placed in the length of the barrel, having an opening at the bottom large enough for a man to get through, to which is attached a hopper for getting rid of any ashes which may accumulate in the chamber. To the bottom of this hopper is fixed a valve which is air-tight, and weighted in such a manner that in its normal position it will be closed. It is, however, connected to a rod leading to the

foot plate, so that it can be opened by the driver when necessary for letting out the ashes.

The barrel of the boiler is 51 in. in diameter and 18 ft. 6 in. long. The combustion chamber is 2 ft. 8½ in. long, and there are two sets of tubes, each set being 156 in number and 2¼ in. in diameter. The rear tubes, extending from the fire-box to the combustion chamber, are 5 ft. 10 in. long, and the forward tubes, from the combustion chamber to the smoke-box, are 10 ft. 1 in. in length. The outside fire-box casing is 6 ft. 10 in. long. The grate area is 20.5 sq. ft. The heating surface is: Fire-box, 120.6; combustion chamber, 39.1; rear tubes, 493.0; forward tubes, 853.0; total, 1,505.7 sq. ft. The working pressure is 175 lbs. in ordinary service.

The leading and trailing wheels are of the same diameter, 49½ in.; the driving wheels are 7 ft. 1 in. The distance between leading axle and forward, or high-pressure, driving axle is 8 ft. 5 in.; the distance between driving axles is 8 ft. 3 in., and from rear, or low-pressure, driving axle to the trailing axle, 7 ft.; thus making the total wheel-base 23 ft. 8 in., and the rigid wheel-base 15 ft. 3 in. The driving axles have 8½ × 13½-in. journals, and the leading and trailing axles 6½ × 12-in. journals.

The weight of the engine in working order is 116,700 lbs., of which 28,670 lbs. are carried on the leading wheels; 34,720 lbs. on the forward drivers; 34,720 lbs. on the rear drivers, and 18,590 lbs. on the trailing wheels.

The frames are of the ordinary English plate type, the main frame being of 1-in. steel plate. The total length of frame is 32 ft. 5¼ in. over all.

The two high-pressure cylinders are each 15 in. in diameter and 24 in. stroke. The steam-ports are 11 × 1½ in. and the exhaust-ports 11 × 5 in. The valve-motion is of the ordinary curved link type; the valves are of the piston type, and have 4 in. maximum travel, $\frac{15}{16}$ in. outside lap and $\frac{3}{16}$ in. lead in full gear. There are four guides, with a cross-head of corresponding pattern, and the connecting rods are 8 ft. 3 in. long. The crank pins have 4 × 5-in. bearings.

The single low-pressure cylinder is 30 in. in diameter and 24 in. stroke. The steam-ports are 20 × 2¼-in. and the exhaust-port 20 × 5¼ in. The valve is worked by Mr. Webb's single-eccentric motion; it has 5½ in. travel and $1\frac{3}{16}$ in. outside lap. The connecting rod is 6 ft. 3 in. long; the bearing on the crank axle is 7¾ × 5½ in.

On its first trip after completion the *Greater Britain*, as this engine is named, was sent from Crewe to London, 157½ miles, with an experimental train, consisting of 23 six-wheeled passenger coaches. The weight of the train at starting was: Locomotive, 116,480 lbs.; tender, 56,000 lbs.; cars, 684,260 lbs.; total, 856,840 lbs., carried on 82 axles. The ratio of the weight of train to that of engine and tender was 3.96 : 1. The length of the train was: Engine and tender, 54 ft.; cars, 880 ft.; total, 934 ft.

The time occupied in the trip was 4 hours, 2 minutes, including a stop of 21 minutes at Rugby. The average speed between Crewe and Rugby was 41.18 miles an hour; between Rugby and Euston Station, in London, 44.59 miles an hour. The particulars of the run are given as follows:

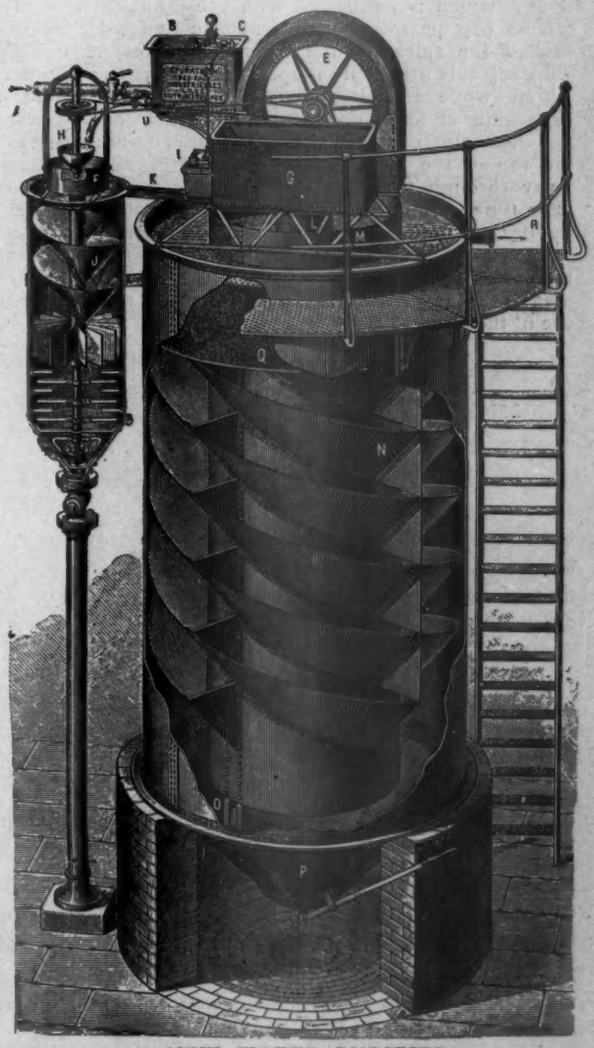
Stations.	Running Times.	Distance in Miles.	Speeds in Miles per Hour.	Weather.
Crewe.....dep.	11:04 A. M.			Fine.
Whitmore.....pass.	11:25 "	10¾	30	"
Stafford..... "	11:42 "	14	49.41	"
Rugeley..... "	11:55 "	9¾	42.69	Strong
Lichfield..... "	12:06 P. M.	8	43.63	side wind.
Tamworth..... "	12:14 "	6¾	46.87	"
Nuneaton..... "	12:33 "	13	41.05	"
Rugby.....arr.	12:54 "	14½	41.42	"
" .....dep.	1:13 "			
Blisworth.....pass.	1:46 "	19¾	38.22	"
Wolverton..... "	2:00 "	10½	45	"
Bletchley..... "	2:07 "	5¾	49.38	"
Leighton..... "	2:15 "	6½	48.75	Rain.
Tring..... "	2:28 "	8½	39.23	"
Watford..... "	2:45 "	14¼	50.89	"
Willesden..... "	2:58 "	12	55.38	"
Euston.....arr.	3:06 "	5¼	39.37	"

The results are computed by Mr. Webb as follows: The coal consumed on the journey was 34 lbs. per mile, or 0.089 lb. per ton of train per mile; the coal consumed, including 10 cwt. used for raising steam before starting, for the single journey from Crewe to Euston, was 41.1 lbs. per mile, or 0.107 lb. per ton of train per mile; if the usual double journey from Crewe to Euston and Euston to Crewe were run, the 10 cwt. for raising steam would be divided over the double trip, or 5 cwt. for raising steam, which would give a consumption of coal of 37.5 lbs. per mile, or 0.098 lb. per ton of train per mile. The tons here are, of course, the English ton of 2,240 lbs.

The total quantity of water evaporated on the journey was 5,896 galls., giving the high average of 10.96 lbs. of water evaporated per pound of coal consumed.

A NEW WATER PURIFIER.

The accompanying illustration, from the *Revue Industrielle*, Paris, shows a new water-softening apparatus devised by M. H. Desrumaux, which is now being introduced by La Société Française pour l'Epuration des Eaux Industrielles, Lille, and which is reported to give excellent



A NEW WATER PURIFIER.

results. Like most of the modern forms of water-softening plant, it consists of two parts—(1) a tank in which the precipitation of the lime salts is effected, and (2) a special form of apparatus for removing the precipitate from the softened water. The preparation of the lime water, which is the reagent used to bring about the precipitation, is also effected in a special form of mixing plant which produces lime water of the maximum strength.

The water to be softened enters the apparatus at *A*, and passes into the small regulating tank *B*, which ensures a constant level, and which distributes such a proportion of the water to the lime in the accessory cylinder *J* as to form sufficient reagent to effect the complete softening of the water, while the remainder and greater portion of the water passes at once into the interior of the precipitation cylinder at *L*. A determination of the hardness of the water indicates the relative distribution of water to the two parts of the apparatus, and, when once regulated, will work without any further attention so long as the charge of lime is unused.

The preparation of the lime water is effected as follows: The tank *F*, with a perforated bottom, is filled with lime, and the adjusted quantity of water flows on to this from the tap *D*. Below the charge of lime at *J* is a concentric helix and paddle, which is set in motion by the revolution of the wheel *E*, which is itself moved by the flow of water into the precipitation cylinder. The revolution of the helix below the lime tank ensures a complete saturation of the water with lime, and thus allows a lime solution of constant strength to pass from the apparatus by the conduit *F* into the precipitation plant. *G* is a reservoir containing soda solution, and it is regulated by the float *I*, which is connected with the tank *B*. The mixed waters first pass down the central cylinder *M*, and then ascend the spiral of the external concentric cylinder. This spiral is fitted with diaphragms at frequent intervals, which, while arresting the passage of the precipitated carbonate of lime, do not hinder the ascending water, which finally passes through the filter *Q* and arrives at the top of the apparatus clear and bright, and passes away through the tube *R*. The precipitate is removed from time to time by opening the precipitation cylinder at the base *P*, and the lime tank *F* is recharged from day to day. La Société Industrielle du Nord (France) recently appointed a committee to examine the working of this plant in that district, and in the report the satisfactory use of these softeners is recorded.

THE PROPOSED TOWER AT CHICAGO.

THE accompanying illustrations show in outline the design prepared by Mr. George S. Morison for a great tower 1,120 ft. high, to be erected in connection with the Columbian Exposition in Chicago. In the drawings fig. 1 is an elevation; fig. 2, a base plan; fig. 3, a plan of the first platform; fig. 4, a skeleton, showing the general arrangement of the work. The whole design is very fully described below by the Engineer himself:

GENERAL DESCRIPTION.

The general arrangement of the tower and the arrangement of the accommodations are modeled from those of the Eiffel Tower at Paris.

The base of the tower is made approximately two-fifths of the height; 200 ft. above the base is placed the first platform, which is to be occupied by promenades, restaurants and miscellaneous accommodations; the level of this is high enough to command the best view of the entire Exposition grounds and buildings. The second platform is placed 200 ft. higher up than the first, though it will not be of so much importance, and 500 ft. higher up is the lantern, which is the principal point for distant views, and is surmounted by a light-house and flag-staff, the whole having a height of 165 ft.

While, however, the general arrangement is derived from that of the Eiffel Tower, the system of construction is necessarily of a very different character. The problem to be solved was to design a tower to be carried on the soft soil on which the city of Chicago is built, this soil being a fine sand which carries large weights perfectly well when they are properly distributed or supported, but has little power in itself to resist lateral thrusts. This rendered anything like the inclined supports of the Paris Tower inadmissible, and further, made it necessary to provide for the expansion of the metal of the tower in a manner which would not strain the foundations.

Besides these considerations of foundations, it was also necessary to design a tower which could be built in the shortest possible time and erected with a maximum speed. This made it necessary to confine the construction to right lines and square angles, and led to the selection of the plan adopted.

The upper shaft from the lantern down to the second platform is a square shaft battering from 40 ft. square at

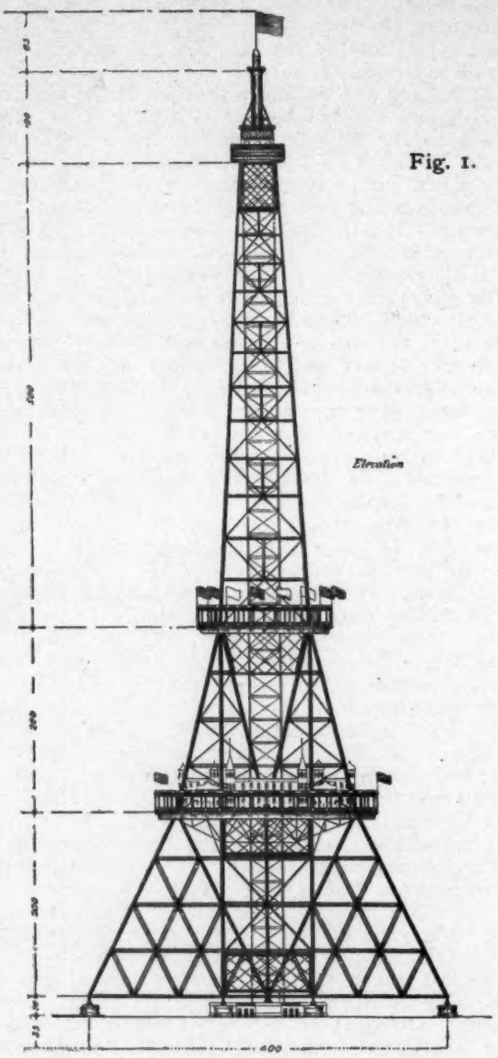


Fig. 1.

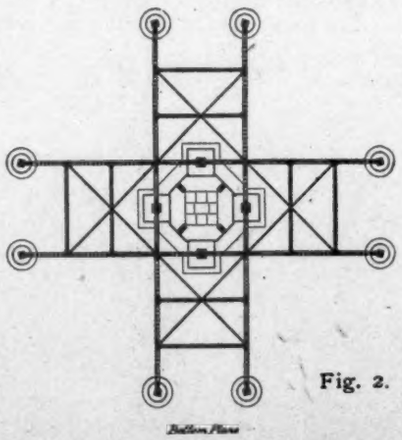


Fig. 2.

the top to 100 ft. square at the base, the entire weight being carried by the four corner posts, which are stiffened by bracing in each of the four planes. The details are of

much the same character as those of the high towers of an iron viaduct. It is the simplest possible form of construction as well as the strongest and most easily erected.

From the second platform to the first each of the four sides of the upper shaft is continued downward in a vertical plane, the four planes intersecting each other on vertical lines 100 ft. apart. Each of the four corner posts is therefore over one of the intersection lines of the planes, and the weight from each of the corner posts is distributed on four posts, two in each plane, these posts battering from each other with an inclination of one in four. The section of the tower, therefore, between the first and second platform consists of 16 posts, of which four are in each of the four planes, the interior posts coming together at the base, and the arrangement of the four posts being like an inverted W, 300 ft. high and 300 ft. wide. The shape, therefore, of the tower at the level of the first platform is cruciform, measuring 300 ft. in each direction and

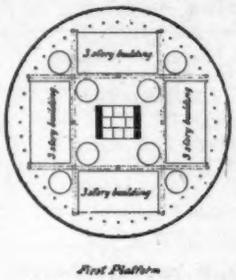


Fig. 3.

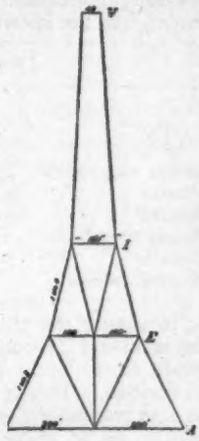


Fig. 4.

100 ft. across each arm. The posts are braced together at intervals of 50 ft. in the four planes.

Below the first platform the weight from the eight interior posts is carried directly to the foundation by vertical posts, while the weight from the exterior posts is carried down on the same principle that the weight from the four posts of the upper shaft is carried—that is, by two equally inclined posts from each point. To bring these posts together at the center it was necessary to double the batter, making it one in two, instead of one in four. Each plane, therefore, of the lower 200 ft. of the tower becomes an inverted W, 200 ft. high and 400 ft. wide on the base, with a vertical member in the center. The members of this plane are stiffened by bracing placed every 50 ft. The base of the tower is then of cruciform section, each arm being 400 ft. long and 100 ft. wide.

The weights of the lantern and the several platforms are provided for at their several levels.

With this arrangement more than half the total weight of the tower is carried on four central points and is a fixed quantity. The remainder is carried on eight outlying piers and varies with the wind pressure. The live load is distributed in the same way, but of course is variable everywhere. The four central points of support are made fixed points and rest on piers which are united into one great foundation. The bearings on the outlying points are all made with expansion links which are able to resist both tension and compression, and the lines of motion of these links are made radial to the center of the tower, so that the expansion of the metal, both longitudinally and transversely, is provided for at the same time. The only expansion not provided for is that due to different temperatures in different parts of the lower horizontal plane, which is so small that it may be neglected. The entire structure is tied across the base and is complete in itself, the only stress transferred to the foundations being a vertical pressure.

The maximum weight thrown by the tower with a complete estimated live load on each of the four central points is 1,760 tons, or in round numbers 7,000 tons on the whole foundation, and the maximum weight thrown on each of the eight outlying piers is 880 tons, this, however, being largely due to wind; the dead load alone thrown upon each of these piers is less than 300 tons.

If these weights are compared with the weights on the foundations of many of the tall buildings in Chicago, and especially under the grain elevators, which are the heaviest and oldest structures in the city, it will be seen that, in spite of the immense size of the tower, the foundations are a comparatively simple thing.

The weight of the structural portions of the tower above the masonry foundations is about 7,000 tons. To this is to be added 2,000 tons for the weights of floors and buildings, and 2,000 tons more for live load, making a total weight of 11,000 tons, of which less than one-fifth is variable.

A grain elevator of 1,000,000 bushels capacity—and there are much larger elevators than this in Chicago—weighs when full of grain at least 50,000 tons, of which more than one-half is variable, besides which it exposes a large flat surface to the wind, and in all respects is subject to much greater disturbing elements than the tower.

ACCOMMODATIONS.

The accommodations, though following the same general arrangement, have been materially increased from those of the Eiffel Tower.

The first platform, fig. 3, which is supported on a cruciform section, is made circular, this shape being easily adapted to the shape of the support. The platform is 250 ft. in diameter. Around this platform runs a covered colonnade 15 ft. wide, the roof being supported by two lines of columns, and a substantial fence being placed between the columns of the exterior row. This forms a continuous promenade unbroken by angles or any local features to check the movements of a crowd. Inside of the circular promenade the platform is left uncovered, except where occupied by buildings. The spaces between the colonnade and the planes in which the structural members are give room for four large buildings 45 ft. wide and 90 ft. long. These buildings will be of light construction and three stories high, and will be occupied as restaurants; the lower stories will be only 7 ft. high and used as serving rooms; the second and third stories will each be 15 ft. high, and these, together with the flat roof, will furnish accommodations for chairs and tables; from each of these floors there will be an uninterrupted view, people on the first floor looking over those walking on the promenade; people on the second floor looking under the roof of the colonnade, and those on the roof looking over the roof of the colonnade. In the interior, besides the space occupied by the four large buildings, there will be room for a number of small buildings to be occupied by various small booths and other buildings.

The lantern will be supported on the four corner columns, which are 40 ft. apart, the length of the diagonal being therefore about 57 ft. The lantern is made 60 ft. in diameter and two stories high, each story, however, to be but 7½ ft. high. This will give two rooms, each having a circumference of 188 ft., which would be the lookouts of the tower, thus giving nearly 400 ft. of observation wall. The circular outside wall of each floor would be made solid for a height of about 3 ft. from the ground; the next 3½ ft. will be of plate glass, and above this will be a frieze, which will be graduated to mark the points of the compass, and the names of important places can be painted in the proper directions; this circle will be of such size that each degree will be more than 6 in. long. Above the two observation halls will be an open gallery to which the public will not be admitted, but on which a small circular railroad can be laid on which a powerful electric light can travel so as to make variable effects of colored light, while within this track will be a smaller building containing rooms for special purposes. Above this small building a round shaft made of boiler plate 12 ft. in diameter will extend 60 ft.; this shaft will contain a spiral staircase leading to the highest platform of the tower, 1,020 ft. above the graded surface of the ground. Above this platform will be a lighthouse surmounted by a flag-staff, the total height from the ground to the top of the flag-staff being 1,086 ft., and from the bottom of the foundation to the top of the flag-staff 1,120 ft.

Within the main structure is to be built a secondary structure 36 ft. square and of uniform size throughout, extending from the foundation to the lantern. This structure is to hold the elevators. It is divided into nine shafts of approximately equal size, eight of which will be occupied by the elevator cars, and the ninth at the center will hold the machinery. Each elevator car will have an area of 100 square feet and be capable of carrying 50 people. The four corner cars will run to the first platform; two of the others will run to the second platform, stopping at the first; the other two will run to the top of the tower. There will be separate entrances at the base to the three different classes of cars, so that no confusion can result.

A double staircase will be built around the elevator shafts from the foundation to the first platform, and a single staircase from the first to the second platform.

CONSTRUCTION.

FOUNDATIONS.—The foundation work will comprise eight outlying piers supporting the exterior bearings of the tower, and the central pier, which supports the center bearing. The general principle adopted for these foundations is that of concrete piers resting on piles. The weight per pile will be limited to from 10 to 15 tons, according to observations to be made when work is actually begun. These weights are without any allowance for the bearing on the ground surface between the piles; if the piles were entirely omitted the weight on the surface would be from 1½ to 1¾ tons per square foot.

The concrete foundation will begin 2 ft. below mean water in Lake Michigan, and the piles would extend up three feet into the matrix of concrete. All concrete will be first class Portland cement concrete. The central pier will contain 7,500 yards of concrete and be supported on 1,600 piles. Each of the outlying piers will contain 700 cubic yards of concrete and be supported by 185 piles.

Above the concrete foundation, which will be about level with the graded surface of the ground, will be built separate piers, one on each of the outlying foundations and four on the central foundation. These piers will be of limestone with heartings of Portland cement concrete, the piers on the central foundation being 30 ft. square and 14 ft. high, and those on each of the outlying foundations 20 ft. in diameter and 11 ft. high. The total amount of masonry and concrete in all the foundations is somewhat more than 15,000 cubic yards.

STRUCTURAL METAL.—The tower will be built of mild steel and of wrought iron; wrought iron being used only in the lighter members. The principal columns are of square box section, fitted with man-holes and interior ladders for purposes of inspection and convenience of workmen. These columns below the second platform will be 40 in. square, and above the second platform they will taper, decreasing from 40 in. at the base to 16 in. at the lantern. All the interior columns will be built of plates and angles with open laced sides. All bracing and stiffening members will have riveted connections, so that nothing can get loose; the compression members are generally square, made of four angles at the corners and with all four sides laced; the tension members are made of four bulb angles placed in pairs, back to back, with a single line of lacing.

The weights on all the floors are taken at 100 lbs. per square foot, of which one-half is treated as live load. The weights of the tower used in the calculations are the actual weights of the metal. A wind pressure of 50 lbs. per square foot on the entire structure is provided for, and a wind pressure of 80 lbs. per square foot on the lantern is provided for in all members above the second platform.

With these conditions the strains are limited to 14,000 lbs. per square inch on square box columns, within a maximum unsupported length of 16 times the width, and these strains are reduced for longer columns, or when thin metal is used in the plates. Where any member is subject to both tension and compression, the sum of the two strains is used in determining the section.

The interior elevator shaft will be of the same character of material and will rest directly on the central foundation.

The entire structure will be incombustible, the floors of the platforms being covered with asphalt or cement concrete, and no wood being used anywhere for structural purposes.

CLASSIFICATION OF PIECE-WORK ON LOCOMOTIVES.

THE subject of piece-work in locomotive and railroad shops has been much discussed, and in many shops the system has been more or less completely adopted, usually with very good results. Its use is extending; and as the arrangement and classification of the work requires care and consideration, we believe that the classification given below will be of interest to many.

This classification is that which has been adopted for the shops of a leading railroad, in which new construction as well as repair work is done, and is for an eight-wheel passenger locomotive. In use it is made out in table form, like the specimen given below:

FOUR-WHEEL ENGINE TRUCK.

Pieces.	Per piece.	Per pair.	Price.	Remarks.
Boring center casting.....				
Planing " "				
Drilling " "				
Boring wheel center				
Turning " "				
Planing pedestal				

In giving the classification below, it has been thought unnecessary to continue the table form throughout, the main object being to show the items into which the work is divided. This is well indicated by the list given, which is also interesting as giving an idea of the number of pieces which go to make up a complete locomotive, and the variety of work which has to be done upon them.

FOUR-WHEEL ENGINE TRUCK.

Molding Center Casting.
" Wheel Center.
" Pedestal.
" Journal Boxes.
" " " Cellars.
" Axle Collar.
" Liners.
" Spring Seat.
" Sponge Cup.
" " " Cover.
" Journal Bearings.

Forging Side Frames.
" Axles.
" Equalizers.
" Pedestal Braces.
" Cross Braces.
" Spring Hangers.
" " " Pins.
" " " " Thimbles.
" Truck Springs.

Rolling Steel Tires.

Boring Center Casting.
Planing " "
Drilling " "
Boring Wheel Center.
Turning " "
Planing Pedestal.
Slotting "
Drilling "
Planing Journal Boxes.
Slotting " "
Drilling " "
Planing " " Cellars.
Boring " " "
Drilling " " "
Boring Axle Collars.
Drilling " "

Turning Sponge Cup.
Drilling and Fitting Sponge Cup.
Planing Journal Bearings.
Babbitting " "
Drilling and Fitting Journal Bearings.
Planing Side Frames.
Slotting " "
Drilling " "
Cutting off Axles.
Turning Axles.
Fitting Axles into Wheel Center.
Slotting Equalizer.
Drilling "
Planing Pedestal Braces.
Drilling " "
Planing Cross Braces.
Drilling " "
" Spring Hanger.
Turning " " Pin.
Drilling " " "
Boring Steel Tires.
Shrinking " "
Building Truck (Complete).

ENGINE FRAMES.

Pedestal Blocked at furnace.
" Trimmed at forge.
Back End Frame at furnace.
" Brace Frame at furnace.
Front Brace Frame at furnace.
Welding Frame.
Frame Tongue at furnace.
" " " forge.
Intermediate Brace at forge.
Pedestal " " "
" Collar Bolt at forge.
" Wedge " " "
" " " Guard at forge.
Frame and Boiler Brace " "
Throat Brace at forge.
Frame Brace 1¼ × 5½ at forge.
" " 1¼ × 3 " "
Boiler Liner at forge.
Tail Brace Top at forge.
" " Bottom at forge.
Friction Wedge at forge.
Frame Clamp 9 × ¾ at forge.
" " 8 × ⅝ " "

Molding Step under Tail Brace.
" Pedestal Shoe.
" " Wedge.
" Friction Casting.
Planing Frames.
Slotting "
Fitting up Frames.
Setting " "
Drilling and Applying Clamps.
Planing Frame Tongue.
Slotting " "
Planing Intermediate Brace.
Slotting " "
Planing Pedestal Brace.
Slotting " "
Planing Tail Brace.
Slotting " "
Planing Friction Casting.
Drilling " "
Planing " Wedge.
Drilling " "
Planing Boiler and Frame Brace.
" Throat Brace.
" Frame " 1¼ × 5½.
" " " 1¼ × 3.
" Pedestal Shoe.
Drilling " "
Tapping " "
Planing " Wedge.
Drilling Steps.
Tapping "

CYLINDERS.

Making Cylinder Cores.
" " Head Cores.
" " " Casing Core.
Molding Cylinder.
" Front Cylinder Head.
" Back " "
" Front " Casing
" Back " "
" Center Casting.

Turning " "
Boring " "
Drilling " "
Boring Cylinder.
Planing "
Milling "
Drilling "
Tapping " for Studs.
Grinding " " Back Heads.
Chipping and Fitting for Smoke Box.
Drilling for Bolts.
Mounting Cylinders and Fastening to Frames.
Fitting Studs in Cylinders.
Turning Front Cylinder Head.
" Back " "
Boring " " "
Drilling " " "
Turning Front Cylinder Casing.
" and Boring Back Cylinder Casing.
Working Cylinder Lagging.
Putting on Cylinder Lagging.
Making Cylinder Casing.
Putting on Cylinder Casing.
Making and Putting on Copper Joint.

CYLINDER COCKS.

Molding Cylinder Cock.
" Handle for Cylinder Rods.
Forging Set of Cylinder Cock Rigging.
Turning Cylinder Cock.
" " " Valve.
" " " Shaft.
" " " Arm.
" " " Pins.
Fitting up Cylinder Rigging Complete.

STEAM CHEST.

Molding Steam Chest.
" " " Cover.
" " " Casing.
" " " " Cover.
" " " Gland.
" Slide Valve.
" Balance Plate.
" Side Strips.
Forging Valve Yoke.
" " Stem (socket) End.
" " " (boss) End.
Planing Steam Chest.
Boring " "
Planing " " Cover.
Drilling " " "
" and Tapping Steam Chest for Relief Valve.
Planing Valve.
" " Strips.
Fitting up Valve.
Turning Valve Yoke.
Planing " "
Slotting " "
Fitting up Valve Yoke.
" Key in Valve Stem.
Turning Front End Valve Stem.
" Back " " "
" Valve Stem after Welding.
Making and Putting on Copper Joint.
Fitting up Steam Chest and Covers.
" on Casing and Lids.

PISTON.

Molding Piston Head.
" Packing Hulls.
" Piston Gland.
" Brass Nut.
" Bushings.

Forging Piston Rod.

Turning Piston Head.
" and Cutting Thread in Nut.
" Gland.
" Piston Rod.
Cutting Key-way in Piston Rod.
Fitting Rod to Cross Head.
" in Piston Key.

GUIDES.

Molding Top Guide.
" Bottom Guide.
" Guide Oil Cup.

Forging Guide Yoke Brace.
" " Blocks.
" " Bolts.

Planing Guide Yoke.
Slotting " "
Boring " "
Drilling " "
Setting " "
Planing "
Slotting "
Drilling "
Planing " Blocks.
Turning " "
Drilling " "
Milling " "
Turning " Block Washer.
Fitting in Guide Block Key.
Turning Oil Cup.
Fitting up Guides.

CROSS-HEAD.

Molding Cross Head.
Forging " " Key.
" Steel Set Screw.

Boring Cross Head.
Planing " "
Slotting " "
Turning " "
Drilling " "
Babbitting " "
Fitting up " "

ROCKER.

Molding Rocker Box, Right.
" " " Left.
" "

Forging Rocker Pin.

Planing Rocker Box.
Drilling " "
Boring " "
Planing " " to fit Frame.
Laying off " "
Fitting " "
Turning "
Fitting "
Boring "

LIFTING SHAFT.

Molding Lifting Shaft Stand.
Forging " " Solid.
Turning " "
Drilling " "
Fitting " "
Planing " " Stand.
Boring " "
Drilling " "

VOLUTE SPRING.

Forging Volute Spring.
" " " Rod.
Fitting up " "

LINKS.

Molding Link Die.
" " Block.

Forging Links.
" Hanger.
" Link Saddle.
" Die Pin.
" Link Hanger Pin.

Planing Link.
" Die.
" Block.
Drilling Link.
Fitting Links together.
Radiusing Links.
Boring out Die.
Drilling "
Planing Saddle.
Drilling "
Planing Die Block.
Drilling Links.
Fitting Bolts.
Turning Hanger.
Drilling "
Slotting "
Fitting up Links, and all Connections.

ECCENTRIC.

Molding Eccentric.
" " Strap.
" " Oil Cup.

Forging Eccentric Hook, Foot.
" " " Jaw.
" " " Center Piece.
" " Bolts.
" " Hook Jaw Bolts.
" " " Feet Bolts.
Welding " " and Jaw.

Planing Eccentric.
Drilling "
Fitting "
Boring and Turning Eccentric.
Slotting Eccentric.
Fitting in Set Screws.
Planing Eccentric Strap.
Drilling " "
Fitting " "
Turning " "
Planing " Hook Jaw
Slotting " " "
Drilling " " "
Planing " " Feet.
Drilling " " "
Slotting " " "
Turning " Oil Cup.

REVERSE BAR.

Forging Lead Bar Ends.
" Reverse Bar Rigging.
" " " Trigger.
" " " Strap.
" " " Rack.
" " " Brackets.
Welding " "

Molding " " Stand.
" " " Bushing.
" " " Handle.

Slotting Lead Bar Ends.
Planing " " "
Drilling " " "
Turning Reverse Bar Ends.
Slotting " " "

Planing Reverse Bar Trigger
" " " Rack.
" " " Clamp.
Fitting up Reverse Bar.

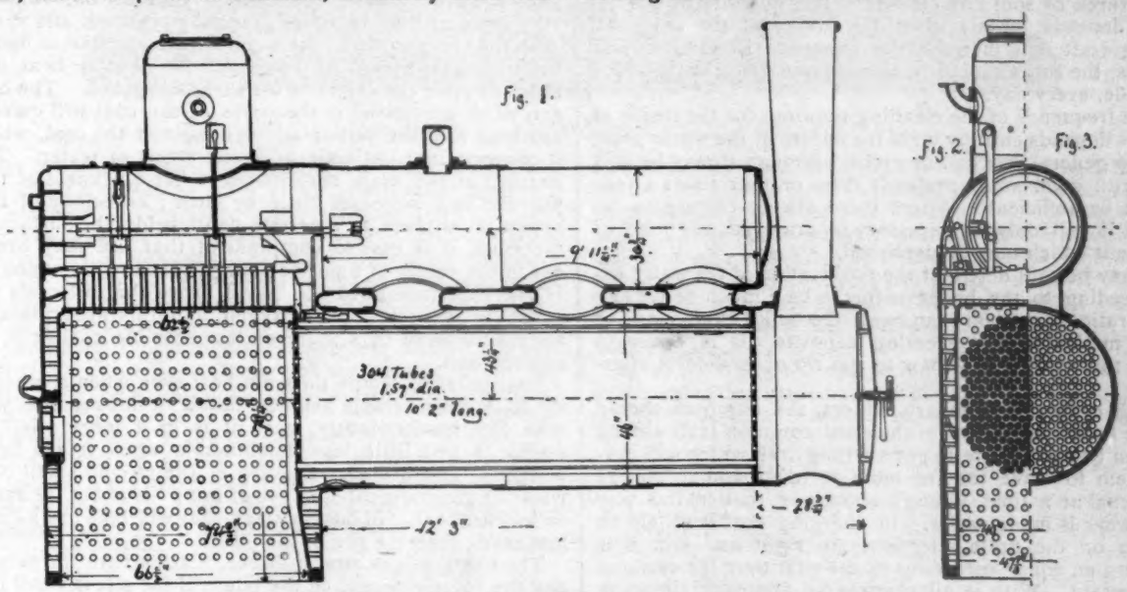
It will be seen that this classification is a very complete one, including the work of all descriptions. It will be continued in the next number.

(TO BE CONTINUED.)

AN EXPERIMENTAL LOCOMOTIVE BOILER.

THE sketches given herewith show an experimental locomotive boiler built by the Eastern Railroad of France, from the design of M. Flamand, Consulting Engineer of the company. Fig. 1 is a longitudinal section; fig. 2 a half cross-section through the fire-box, and fig. 3 a half section through the barrel.

As will be seen from the drawings, the barrel of the boiler, which is 46 in. in diameter, is entirely filled with tubes; there are 304 in all, 1.57 in. in diameter and 10 ft. 2 in. long. The upper barrel or steam-drum is connected with the outer fire-box casing at the rear end and has also three connections with the main barrel; it is 30¾ in. in diameter and 9 ft. 11¼ in. long. The usual water level is just below the center-line of this upper barrel.



EXPERIMENTAL BOILER, EASTERN RAILROAD OF FRANCE.

It is claimed that this form of boiler, taking all its heat from the fire-box and tubes directly, will utilize a larger proportion of the heat than the ordinary locomotive type, and will not require any form of superheater or return tubes.

The boiler shown was built for an old locomotive of the Crampton pattern—which still finds some favor in France—and was worked at a service pressure of 145 lbs. It has been in use about 18 months, and the results obtained have been so good that the company is now building 12 boilers of the same pattern for new locomotives.

NOTES ON COMBUSTION.

BY C. CHOMIENNE, ENGINEER.

(*Continued from page* 549, *Vol. LXV.*)

RECAPITULATION.

THE use of an anemometer with each fire-box will enable us to determine the draft at each moment of the combustion, and to ascertain at the same time the precise quantity of air needed to obtain the maximum useful effect with different varieties of coal.

Frequent analyses by the Orsat apparatus of the gases which escape into the chimney will permit us to ascertain whether all the air has been properly employed in burning the coal.

Heretofore only natural draft has been used with chimneys of a height varying from 30 m. to 40 m. A chimney of 30 m. is sufficient to produce a draft of 0.016 to 0.018 m. with gases, the temperature of which varies from 200° to 230° C. To obtain a stronger draft, it is necessary to increase the height considerably. Thus a chimney of 45 m. gives only a draft of 0.025, and the capacity with an equal section is only one-sixth greater than that of a chimney of 30 m. This shows that it is better to increase the section than the height, the capacity increasing proportionally to the square of the diameter. We should only resort to an increase of height in those cases where high ground or a neighboring high building forces us to do so in order to prevent injury to the draft. With stationary boilers nothing has been said of the forced draft which is used on railroads and with marine boilers. This forced draft serves to increase the activity of combustion, but is not economical because the gases escape at a very high temperature in consequence of the rapidity with which they are forced through the boiler, and which prevents them from giving up a sufficient proportion of their heat.

In locomotive boilers, for instance, where the draft corresponds to 0.025 to 0.075, the temperature of the gases in the smoke-box varies from 290° to 350° C. for boilers of the ordinary size, which indicates a loss of between 12 and 14 per cent.

As to blowers, either steam or air, they have the fatal effects of introducing complication in the firing and of consuming steam in such quantity that so far none of them have given the economical results hoped for. It is the case with these blowers that they have produced a mixture of gases which tends to facilitate combustion, but at the same time the gases are cooled, which tends to arrest the combustion; and it is because of this contradiction that few of them have given good results.

To sum up: if we wish to save considerable quantities of coal, it can only be done by removing from the boiler the other causes of incomplete combustion which are much more considerable than those resulting from the waste through the smoke. At the same time we should not neglect the advantages of consuming this smoke.

We must never forget that the result obtained from a boiler varies according to the quality of coal, the form of the apparatus, and lastly the experience and capacity of the firemen. From careful experiments made in Alsace and in Belgium, it was pretty well shown that the type of

boiler has not the excessive importance which has been sometimes attached to it. To obtain a good result, it is not wise to require an excessive amount of work from the boilers. The principal point is to have a proper proportion of heating surface, and it is the selection of this proportion which constitutes the chief point of merit in a steam generator.

For a manufacturing establishment other points must be taken into account, including the price or cost of setting, ease in cleaning and repairs; these things are often forgotten or not sufficiently considered. For large boilers in manufacturing establishments the combustion which has given the best results is generally included between 1 kg. and 1.5 kg. of carbon per square meter of heating surface per hour, and the ratio between the grate area and the heating surface should be about 1 : 50.

In firing the stirring up and cleaning of the fire should be done at the proper time. The passages to the chimney and the outside of the boiler should be cleaned frequently, as a rule not less than twice a month. A loss in efficiency will be noticed at once if the exposed surfaces are left to be covered by soot and cinders. The quantity of this deposit depends largely upon the quality of the coal, and strong draft will increase the amount. In semi-tubular boilers, the tubes should be cleaned out frequently—where possible, every day.

The frequency of the cleaning required for the inside of boilers depends entirely upon the nature of the water used; and no general rule can be given, although it may be said that with good water probably three or four times a year would be sufficient. Where there are no calcareous deposits it will only be necessary to draw off any mud or sediment which may be deposited.

It may be said here that the purification of the water before feeding to the boiler seems to be a much better and more rational method than to employ boiler compounds or other methods for preventing deposits. It is easier to make the water pure than to get rid of its defects afterward.

With ordinary stationary boilers, the dampers should not be kept too wide open, the most common fault among firemen being a desire to get a strong draft which will permit them to leave the fire more to itself, and to charge more coal at a time, wrongly supposing that in this way their work is made easier. In charging coal it should be thrown on the grate alternately to right and left, thus securing an equal spreading of the coal over the surfaces of the grate. With small charges we approach almost to continuous feed and the fire will burn much more rapidly. In large boilers the fire-box should be charged at intervals of from 8 to 12 minutes, care being taken that the fire-doors are not left open too long. Between the times of charging, when the coals are of a coking quality, the fireman should look at his fire-box, break up lumps which are brought together, and see that his fire is as even as possible, by filling up vacant spots or places where the fire is low and air can pass through too easily.

Dry coals do not coke or run together. The lumps preserve the forms and intervals, and as the air passes through it more easily, we can use a greater thickness of fire. With these coals we need a directly opposite treatment to the oily coals, and the fire should not be stirred up too often. If it is, too much is lost in the ashes.

The thickness of the fire should correspond with the draft in order to secure complete combustion without any excess of air. It should be determined with care, taking into account the kind of coal and the draft. If we assume a consumption of 75 kgs. of coal per square meter of grate per hour, with charges at intervals of 10 minutes, the quantity of coal would then be about 12.5 kg. to the square meter of grate at each charge.

These are, we believe, the conditions which we ought to try to realize with any system of fire-box. By following these ideas, we can obtain a considerable economy; especially when re-heaters are used, we increase the power of the boilers, and by employing a sufficient quantity of air and the proper mixture of combustible gases, we will attain an almost complete freedom from smoke.

We may add that it is indispensable that the coal should be stored in a covered shed, for if it is too much exposed the vapor of water absorbed will prevent or decrease in part the combustion of the gases. Certain coals, chiefly those known as gas coals, when exposed to the air undergo a rapid alteration, the combustible gases being disengaged and their heating power is then considerably decreased. Such coal should be used as soon as possible after it is mined. This disengagement of the gases sometimes amounts to a sort of slow combustion.

SPONTANEOUS COMBUSTION.

A theory recently presented by Professor Vivian Lewis, in London, differs from that heretofore adopted in England, but it agrees with that of M. Fayol, Engineer of the Commentry Coal Mines, which was submitted to the Mining Congress at Paris in 1878. He claims that coal possesses in a very high degree the property of condensing gases on its surface, in proportions which vary according to the nature of the coal, its state of division and its density.

Freshly mined coal has not a constant absorptive power, but it can retain at least 1.25 times its own volume of oxygen, and sometimes three times. This action, which is very rapid at first, becomes gradually reduced, and varies with the temperature. It is purely mechanical in its nature, is accompanied by the production of some heat, and depends upon the extent of the surface exposed. The oxygen when condensed in the pores of the coal will quickly combine with the carbon and hydrogen of the coal, which it converts into carbonic acid and vapor of water. The heating of the mass contributes to the quickness of this process and increases little by little; especially if this action takes place at a certain depth below the surface of the mass, it is easy to comprehend that fire may break out in the center of a pile or a cargo of coal without notice.

The experiments of Mr. Fayol prove that all coals exposed to the air absorb oxygen, and this absorption is always followed by a more or less sensible change in its composition.

Coal in large lumps does not heat even when it is piled up to a considerable height. Small or broken coal will take fire spontaneously when it is in a large pile. It seems to be a little less inflammable when it has been washed. The ordinary mixture of lumps and small coal which is generally called "run of mine" is about the same as washed coal. In dust or slack coal will take fire a little less easily than the run of the mine.

The heating is in almost direct relation with the height and the volume of coal in the pile. If the pile is small the temperature will increase to a certain degree, depending upon circumstances, and will then remain stationary and finally will slowly diminish. There is no example on record of a pile of less than 2 m. in height taking fire, and the temperature will seldom pass 50° C. On the other hand, when the height is over 4 m., spontaneous combustion is almost sure to come after a certain time.

The temperature increases gradually, and in the course of the third month some steam will be given off by the pile; then colorless, but strongly odorous gas, while some days afterward smoke will appear at a point at about half the height of the pile.

The best method of preserving coal from deterioration consists in exposing it as little as possible to the air and keeping it at a low temperature. The absorption of the oxygen by the coal increases rapidly as the temperature rises, being about ten times as quick at 100° C. as at the ordinary temperature. Dampness prevents the heating rather than favors it, since washed coal when piled up in a damp state changes and heats less than before; but where the coal is in large lumps dampness may exercise an indirect action by breaking up these lumps and facilitating their reduction to dust. Coals are generally more inflammable as they are lighter, more porous and richer in volatile matters. Coals having much pyrites change but little at the ordinary temperature, but the action is increased in damp air. The order of inflammability of different coals and the temperatures at about which they will take fire may be set down as follows: 1. Lignite, 150° C.; 2. Gas coals, 200° C.; 3. Dry coals with short flame or coking coals, 250° C.; 4. Anthracite, above 300° C.

(TO BE CONTINUED.)

TESTING A COMPOUND LOCOMOTIVE IN EXPRESS SERVICE.

SOME tests have recently been made with a compound locomotive built by the Rhode Island Locomotive Works, and designed for making fast time on trains with few stops. This locomotive—No. 2,600—is of the two-cylinder type, provided with the intercepting valve used by the Rhode Island Works. This valve is so arranged that when the throttle valve is opened at starting, steam from the boiler is admitted directly into the low-pressure cylinder, this admission ceasing when a predetermined pressure in the receiver has been reached by exhausts from the high-pressure cylinder. The engine thus has the advantage of working with high-pressure steam in both cylinders in starting, and the valve is also arranged so that the engineer can change from compound to simple working at will.

The results of these tests have been published by the Rhode Island Works in a very complete form. We give herewith a condensed summary of the results, space preventing the use of the complete tables and other interesting data.

Two tests were made on the New York, Providence & Boston, and two on the Boston & Albany Railroad, the compound No. 2,600 being run on each road with an engine as nearly as possible of the same capacity. The dimensions are given in the table below:

TABLE I. COMPARATIVE DIMENSIONS OF LOCOMOTIVES.

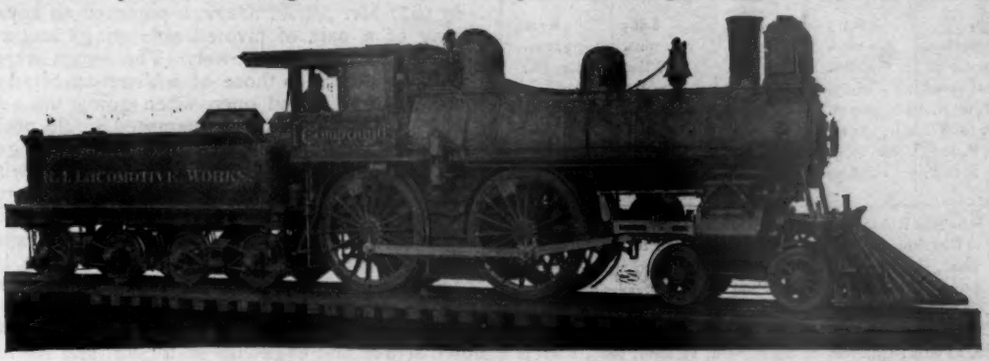
	Compound, No. 2,600.	N. Y., Prov. & B., No. 34.	Bost. & Albany, Nos. 173 & 136.
Fuel used	Soft coal.	Soft coal.	Soft coal.
Cylinder, High-pressure	18×24 in.	18×24 in.	18×22 in.
" Low-pressure	28×24 in.		
Drivers, diameter	78 in.	72 in.	70 in.
Boiler, diameter of barrel	52 in.	52 in.	52 in.
" outside diameter of tubes	2 in.	2 in.	2 in.
" number of tubes	214	200	221
" length of tubes	10 ft. 10 in.	11 ft. 10¾ in.	11 ft. 0 in.
Grate, style of	C't i'n r'k'g.	C't i'n, r'k'g.	C't i'n r'k'g.
" size of	78⅛×34⅜ in.	72⅛×34⅜ in.	71⅛×35¼ in.
" area	18.65 sq. ft.	17.72 sq. ft.	17.41 sq. ft.
Heating surface, fire-box	*157.57 sq. ft.	120.95 sq. ft.	116.78 sq. ft.
" " tubes	1,086.26 sq.ft.	1,115.68 sq.ft.	1,119.84 sq. ft.
" " total	1,243.83 sq.ft.	1,236.63 sq.ft.	1,236.62 sq.ft.
Ratio of grate area to heating surface	1:66.69	1:69.78	1:71.02
Weight in working order	103,230 lbs.	91,250 lbs.	91,000 lbs.
" on drivers	66,520 lbs.	60,200 lbs.	61,500 lbs.
" on truck	36,710 lbs.	31,050 lbs.	29,500 lbs.

* Including 19.63 sq. ft. fire-brick tubes.

On the New York, Providence & Boston the conditions were very nearly those for which No. 2,600 was specially designed. The road is 64 miles long, with a rolling profile, there being grades each way from 0.5 to 1 per cent., while the line is practically straight. On this road the trains hauled were through passenger, in the first test consisting of seven and in the second of six cars; only one regular stop was required on each trip.

The general results of these tests are given in Tables II and III herewith. On the second one the water used was measured; this was not done on the others, chiefly on account of the delay and difficulty caused when taking water on the road. The coal used on this road was ordinary bituminous, about half lumps.

On the Boston & Albany the service was very different, being over a road with many steep grades and bad curves, some of the latter occurring on the worst grades. The speed on down grades is restricted by rule to 42 miles an hour, limiting the amount of time which can be made up. On this road many extra stops and slowings were required in passing freight trains, and because repairs to the track were in progress at different points. The compound was run here with two different locomotives, but both were of the same dimensions throughout, and, as nearly as possible, in the same condition. The coal used on this road was the best quality of Pocahontas, W. Va., well mixed with lumps.



COMPOUND LOCOMOTIVE, RHODE ISLAND LOCOMOTIVE WORKS.

In all the trials the competing engines were run on the same trains, the same number of days, with the conditions as nearly alike as possible, enough days being taken to

TABLE II. SUMMARY OF NEW YORK, PROVIDENCE & BOSTON TEST NO. 1.
Three Round Trips between Providence and New London.

	Compound, No. 2,600.	N. Y., Prov. & B., No. 34.
Total car mileage	2,752	2,752
" coal consumption	9.17 tons.	12.27 tons.
Average amount of coal used per car mile	6.66 lbs.	8.91 lbs.
Percentage of coal saved	25.2 per cent.	
Average running time, Prov. to N. London	1 hr. 39.6 min.	1 hr. 38.6 min.
" " " N. London to Prov.	1 hr. 44.0 min.	1 hr. 39.0 min.
Average miles per hour, Prov. to N. London	38.63	39.25
" " " " N. London to Prov.	37.21	38.88

Schedule running time from Providence to New London, 64 miles: 1 hr. 40 min.
" " " " New London to Providence, 64 miles: 1 hr. 41 min.

TABLE III. SUMMARY OF NEW YORK, PROVIDENCE & BOSTON TEST NO. 2.
Six Round Trips between Providence and New London.

	Compound, No. 2,600.	N. Y., P. & B., No. 34.
Total car mileage	4,608	4,608
Total coal consumption	13.59 tons.	15.90 tons.
Average amount of coal used per car mile	5.9 lbs.	6.9 lbs.
Percentage of coal saved	14.52 per cent.	
Average running time, Prov. to N. London	1 hr. 30.7 min.	1 hr. 31.0 min.
" " " N. London to Prov.	1 hr. 27.0 min.	1 hr. 27.3 min.
Average miles per hour, Prov. to N. London	43.04	42.84
" " " " N. London to Prov.	44.84	44.72
Water evaporated in boiler	23,812 galls.	25,140 galls.
" used in cylinders	23,706 "	25,087 "
Percentage of water saved, used in cylinders	5.50 per cent.	
Lbs. water evaporated per lb. of coal	7.30 lbs. from 53.25°.	6.59 lbs. from 43.2°.

Schedule running time, Prov. to N. London, 64 miles: 1 hr. 35 min.; 1 stop.
" " " N. London to Prov., 64 miles; 1 hr. 35 min.; 1 stop.

TABLE IV. SUMMARY OF TESTS ON BOSTON & ALBANY RAILROAD.

Test No. 1. Nine Round Trips between Boston and Springfield, Trains 19 and 18.

Test No. 2. Seven Round Trips between Boston and Springfield, Trains 83 and 50.

	Test No. 1.		Test No. 2.	
	Compound, No. 2,600.	Bost. & Alb. No. 136.	Compound, No. 2,600.	Bost. & Alb. No. 173.
Total car mileage.....	8,613.5	8,372.5	8,565	8,718
Total coal consumption.	29.0 tons.	39.5 tons.	23.5 tons.	30.5 tons.
Av. am. of c'l per car m.	6.73 lbs.	9.43 lbs.	5 48 lbs.	6.99 lbs.
Percentage of coal saved	28.63%	.....	21.60%	.....
Av. run. time, B. to S..	2 h. 37.7 m.	2 h. 36.5 m.	2 h. 37.4 m.	2 h. 37.3 m.
" " " S. to B..	2 h. 39.5 m.	2 h. 43.5 m.	2 h. 39.0 m.	2 h. 38.0 m.
Av. m. per hour, B. to S.	37.51	37.75	37.53	37.59
" " " " S. to B.	36.32	36.26	37.18	37.39

TEST NO. 1. Schedule Running Time: Boston to Worcester, 44 miles, 68 min.; Worcester to Charlton, 13.5 miles, 24 min.; Charlton to Springfield, 41 miles, 65 min.; total, including stops, 98.5 miles, 2 hrs. 49 min. *Return trip:* Springfield to Charlton, 74 min.; Charlton to Worcester, 23 min.; Worcester to Boston, 70 min.; total, 2 hrs. 49 min.

TEST NO. 2. Schedule running time: Boston to Worcester, 70 min.; Worcester to Charlton, 24 min.; Charlton to Springfield, 64 min.; total, 2 hrs. 41 min. *Return trip:* Springfield to Charlton, 69 min.; Charlton to Worcester, 22 min.; Worcester to Boston, 68 min.; total, including stops, 2 hrs. 49 min.

secure a fair average. The same engineer handled each engine. The engineers in each test had no previous experience with the compound, but were regular runners on the simple engine. In every way the test was fairly conducted. The results can be seen in the tables given.

In view of the results obtained, the builders claim for this type of engine a saving of 15 to 25 per cent. in fuel. They also claim that the compound engine runs easily, with light oil consumption; that there is a remarkable freedom from cinders and black smoke, owing to the smoother and quieter exhaust. The ability to run as a simple engine, as noted above, enables it to be run with either cylinder singly, in case of a break-down, with no more trouble than an ordinary engine.

PROGRESS IN FLYING MACHINES.

BY O. CHANUTE, C.E.

(*Continued from page 561, Vol. LXV.*)

IN the United States very few experiments seem to have been made with flapping wings, and no records of them are attainable. Investigation is, therefore, limited to such proposals as have been patented, and it is found that, aside from balloons, less than 30 flying machine patents have been taken out, of which four are for flapping wings.

The first of these, in order of date, seems to have been the proposal of Mr. *W. F. Quinby*, who patented, in 1869, an apparatus to be operated by man power, consisting of a pair of side wings and a tail, all to be flapped by a series of cords attached to the operator, who is encased in a cuirass which maintains the wings at about the height of his waist. The surfaces shown in the drawings are quite insufficient to sustain the weight, and in 1872 Mr. *Quinby* took out another patent for a modification of his apparatus, in which he added dorsal surfaces, so that the wings and the tail were continuous and resembled the supporting surfaces of a bat. The arrangement for imparting motion was ingenious but futile, because of the inefficiency of muscular power, which has already been stated.

In 1876 Mr. *F. X. Lamboley* patented a framework shaped like the wings of a bird, and covered with a wire netting to which birds' feathers were fastened so as to give a valvular action. Human power was relied upon to impart motion through a trapeze-bar and platform, and of course it would prove inadequate.

In 1877 Mr. *M. H. Murrell* patented an apparatus consisting of a pair of pivoted side wings and a tail, to be also operated by man power. The wings were furnished with slats similar to those of a Venetian blind to close on the down stroke, and open when going up. An investigation of what others had attempted would probably have saved the inventor some misspent time and ingenuity.

So little has been effected with flapping wings that a number of American inventors seem to have turned their attention to various arrangements of revolving vanes. Of these *A. P. Keith* patented, in 1870, an aerial car with paddle-wheels revolving in a transverse plane, for the purpose of lifting and propelling. *Thomas Green* patented, in 1873, an apparatus with two wheels, each with four revolving blades passing through the air flatwise on the down stroke and edgewise on the up, and *M. H. Baldwin* patented, in 1890, an aerial vessel in which weight is to be supported by a set of wheels containing feathering vanes; the wheels revolving in opposite directions on longitudinal shafts. All of these are worthless, as is also the patent of *I. M. Wheeler* of 1887, which covers the

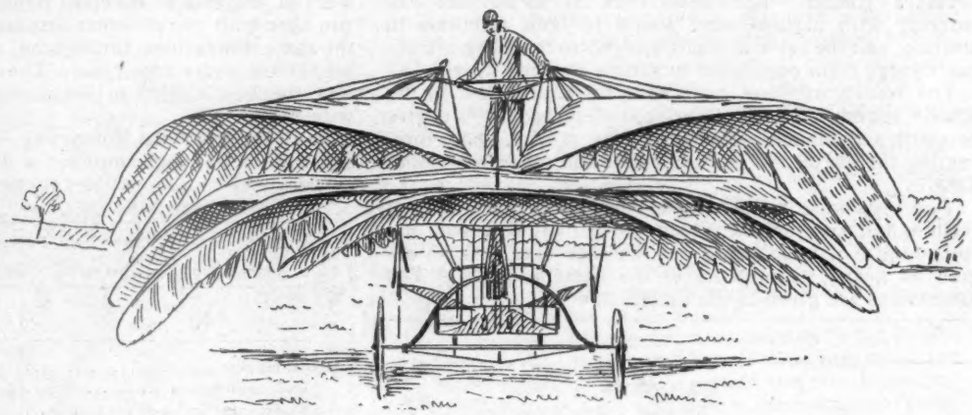


FIG. 22.—FROST—1890.

arrangement of a number of oscillating frames superposed to each other on a mast, and carrying slats similar to those of a Venetian blind; these various devices only being mentioned to illustrate how ingenuity has been wasted upon mechanical details, while scarcely any attention seems to have been given to the devising of the lightest possible motive power. Each fresh inventor of winged machines is apt to imagine that his predecessors did not succeed because they did not hit upon the right method of imitating the complicated and swift motions of the birds. Thus Mr. *H. Sutton*, of Australia, communicated to the British Aeronautical Society, in 1888, that experiment and observation had convinced him that the tips of the bird's wings describe, when viewed from the side, the outline of an inverted cone with rounded base, instead of the figure of 8 motion described by Dr. Pettigrew and Professor Marcy. He had accordingly made a model, driven by clockwork, to test the truth of his theory. This model was not capable of free flight (steel springs and clockwork being much heavier than rubber, in proportion to their stored energy), but when suspended at the end of a counterweighted lever, resting upon an upright support with a ball-and-socket joint, it flew in a circumference of about 12 ft. by the flapping action of the wings. By slightly modifying the stroke of either wing it was made to fly from right to left or from left to right. By altering the guide-rods, which governed the direction of the stroke, it could be made to fly upward at any desired angle, but

the important, the vital question of an efficient motor was left untouched by the inventor.

Still, earnest attempts are occasionally made in the direction of light motors. At the meeting of the British Aeronautical Society, in 1890, a photograph was shown of a steam-bird machine, designed and built by Mr. *E. P. Frost*, which is represented in fig. 22. The wings, which are 30 ft. from tip to tip, are in exact imitation of those of the crow, and the various positions which they assume during a stroke are shown in the picture. The weight of the machine, including engine and boiler, is about 650 lbs. It was expected to carry in addition the weight of a man in the air, but it was said that the maker of the engine failed in his contract to secure the necessary power, and the apparatus did not fly.

At the same meeting Mr. *H. Middleton*, who has been advocating for several years winged apparatus as superior, in his judgment, to aeroplanes, exhibited two bird machines, one weighing 20 lbs., with a wing-spread of nearly 12 ft., and the other of between 10 and 12 lbs. weight with a wing-spread of some 9 ft. He also showed an aeroplane weighing somewhat over 20 lbs., with sustaining planes of 14 ft. across and a screw of 4 ft. diameter, in order to compare its performance with those of the bird machines. Only the smaller of these latter was shown in action, but its balance was not properly adjusted, and although it raised itself from the sustaining horizontal rope during the first few strokes, it soon rested again upon the rope, and on the pressure being raised during a subsequent run, the right wing broke and terminated the experiment.

The aeroplane, being similarly suspended, moved along the rope at a moderately good pace, but without raising itself on the air, and that experiment was brought to an untimely end by the rupture of a joint on the propeller shaft.

Probably the most original conception ever presented for a flying machine is that of M. *G. Trouvé*, who has just revived (1891) the proposal for his mechanical bird, which was first presented to the French Academy of Sciences in 1870. This is shown in fig. 23, and consists of two wings, *A* and *B*, connected together by a "Bourdon" bent tube, such as is used in steam gauges. The peculiarity of this tube, as is well known, is that as pressure increases within it the outer ends move apart, and as pressure diminishes they return toward each other. M. *Trouvé* increases the efficiency of this action by placing a second tube within the first, and in the experimental model he produces a series of alternate compressions and expansions by exploding 12 cartridges contained in the revolver barrel *D*, which communicates with the tube. This produces a series of energetic wing strokes which propel and sustain the bird in the air in connection with a silk sustaining plane indicated at *C*.

The manner of starting the bird is equally ingenious and peculiar, and is shown in fig. 24. The bird is suspended from a frame by a thread, which, being attached to the hammer, keeps the latter off the cap. A second thread holds the bird back from the perpendicular, while a common candle *A* and a blow-pipe flame *B* complete the preparations. Upon the thread being burned at *A* the bird swings forward from position 1 to position 2, where the suspending thread is burned by the blow-pipe *B*, the hammer falls on the cap, an explosion ensues, the wings strike downward violently, and the bird flies on an upward course, as shown in position 3. Then the gases escape from the Bourdon tube, this recovers its shape, raises the wings and actuates two pawls which rotate the revolver barrel and work the hammer, so that a fresh explosion occurs and the bird continues to fly. When the 12 cartridges are exhausted the bird glides gently to the ground, being sustained by its wings and aeroplane as by a parachute. It has thus flown 75 to 80 yards.

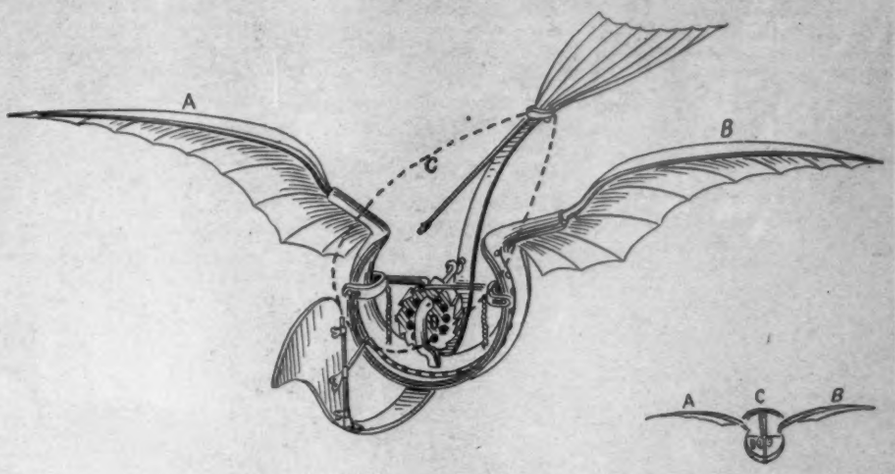


FIG. 23.—TROUVE—1870.

This motor is evidently very simple and very light, and for a practical flying machine M. *Trouvé* proposes to substitute for the cartridges a supply of compressed hydrogen gas, which, when mixed with about three parts of air, becomes an explosive mixture to be fired by the electric spark. Thus the motor would derive the greater portion of its power direct from the atmosphere as wanted, there would be no danger of premature explosion as with fulminates, and, hydrogen being only $\frac{1}{14}$ the weight of air, the weight and the equilibrium of the apparatus would vary but little when supplies became exhausted. Moreover, it is probable that no cooling agent would be required, as in ordinary gas engines, because the tube exposes so great a surface that it is to be expected that the heat would pass into the air while under motion, and that, as there is no piston to be lubricated, a moderate heating would not prove objectionable.

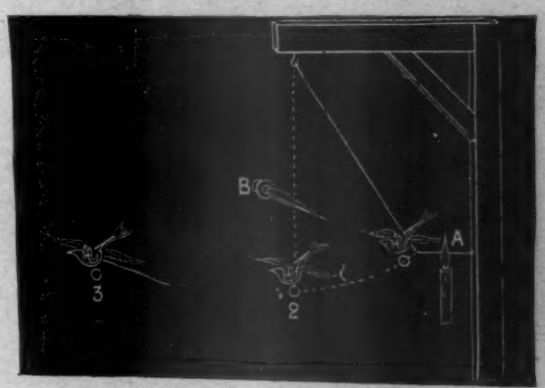
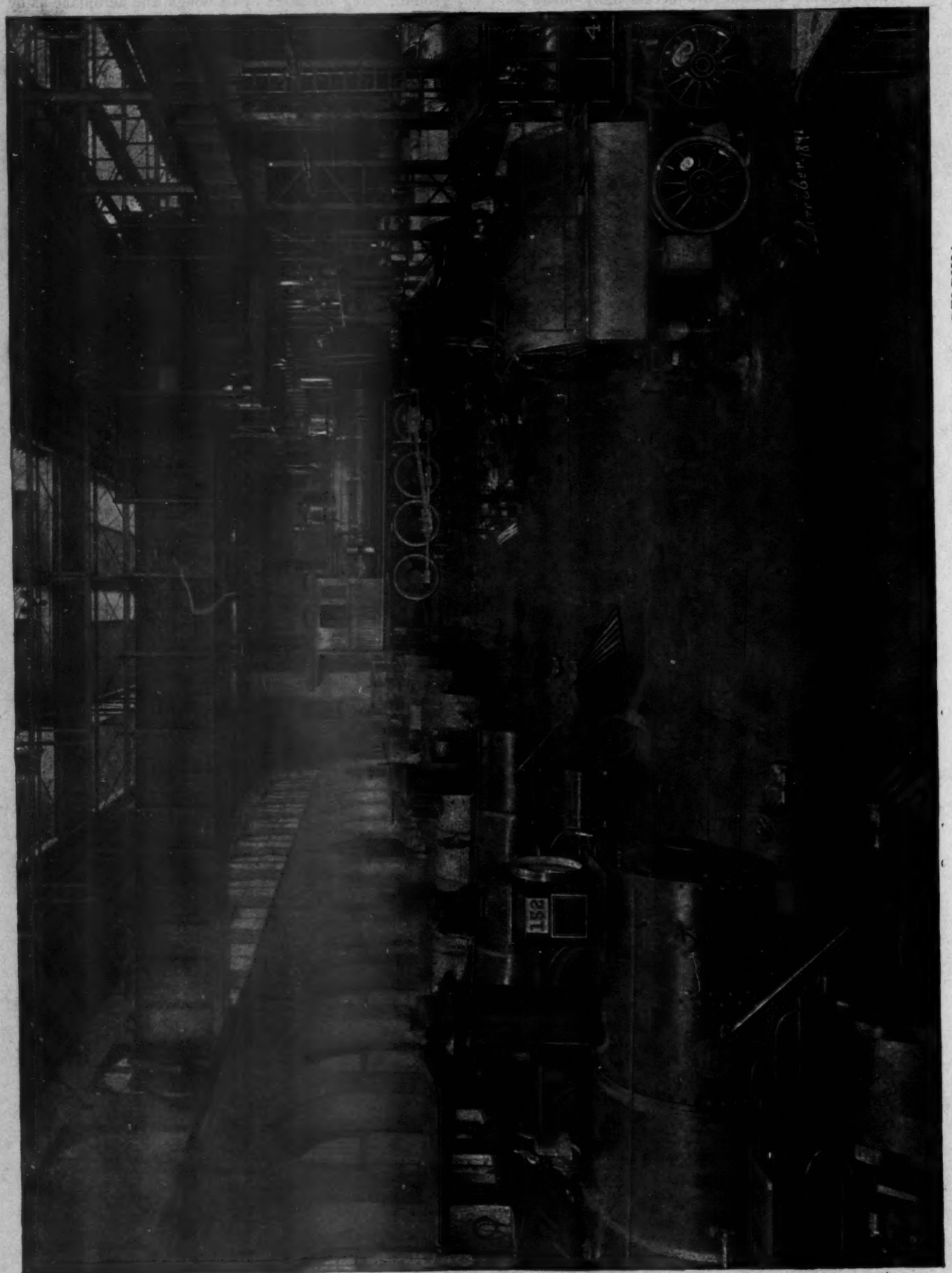


FIG. 24.—STARTING TROUVÉ'S BIRD.

M. *Trouvé* started out with the assumption that a motor for aerial navigation should not weigh over 8 lbs. to the horse power. He presented to the French Academy of Sciences, in 1886, an electric motor, weighing but 7.7 lbs. per horse power, working an aerial screw, which will be more fully noticed when this subject is treated, and on August 24 last (1891) he deposited with the same body a sealed letter containing the drawings and description of an aeroplane and screws, which, he confidently believes, provide a final solution for the problem of aerial navigation, and which will also be noticed under the head of Aeroplanes.

Meanwhile other inventors are also working in the same field, and the English papers have contained sundry paragraphs, within the last few months, concerning a flying



INTERIOR OF NEW ERECTING SHOP, BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

machine some 45 ft. across, in the form of a bat, which is being built in Coventry for Major Moore, of India. It is to be driven by an electric motor, but the descriptions do not make it clear whether this is to be by beating wings or with fixed wings, as in an aeroplane. The cost incurred is stated at over $5000, and the trial is to take place at the Crystal Palace. Should this take place in time, it will be noticed, as well as the great apparatus now being completed by Mr. Maxim, when we come to discuss aeroplanes.

AN ERECTING SHOP INTERIOR.

THE accompanying large engraving is from a photograph showing the interior of the new erecting shop of the Baldwin Locomotive Works in Philadelphia, and gives a very good idea of the appearance of this shop in busy times.

One special feature about the shop is the large traveling crane which is shown prominently in the picture. There are two of these cranes, each of 100 tons capacity, running side by side in the shop, and either one of them is able to pick up and transfer a locomotive of the largest class from one track to another. One of them, it will be seen, is in the act of moving a large consolidation engine in this way.

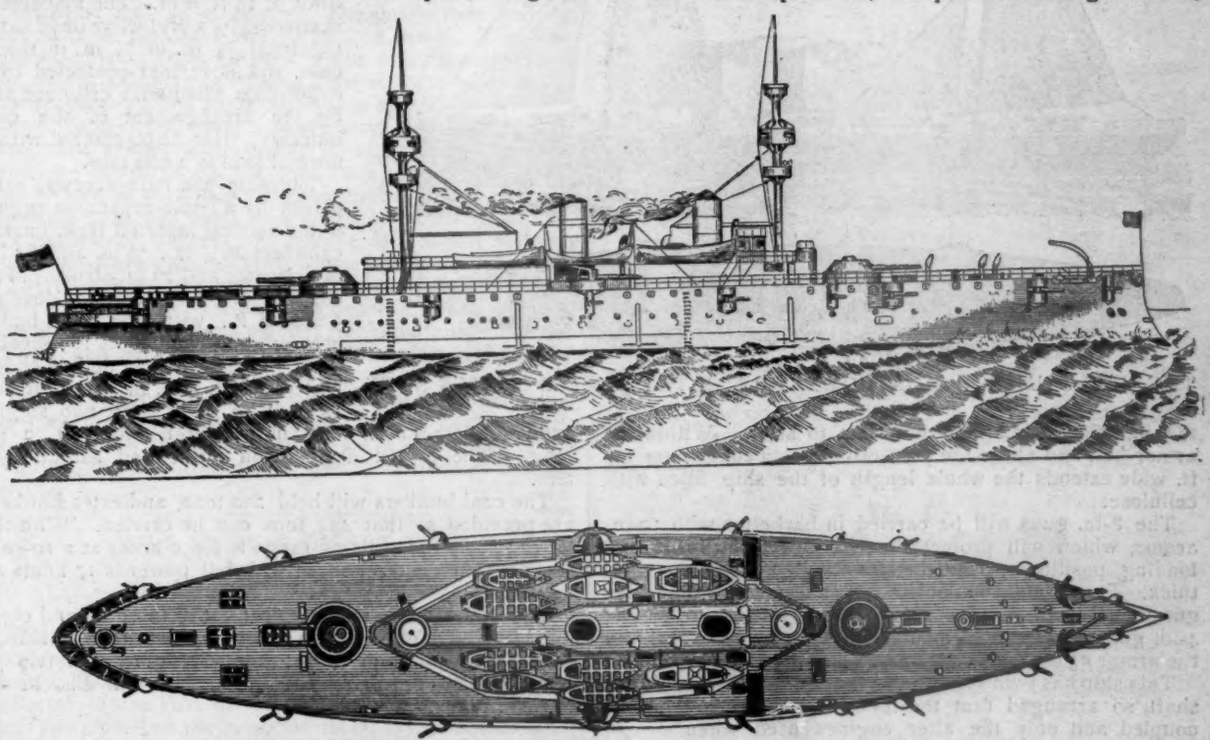
Each crane runs the length of the shop on tracks resting upon the wall on either side, and on girders supported by columns in the center. It is provided with two lifting trolleys of 50 tons capacity, the power being conveyed to these trolleys by a square shaft running the entire length of the bridge inside the girders. The cranes were built by William Sellers & Company, of Philadelphia, and at their suggestion electricity was adopted as the motive power. On each crane there are two 40-H.P. Westinghouse constant-potential shunt-wound motors, mounted on the top of the bridge and geared independently to the driving machinery. These motors run in the same direction at all times, the reversing being done by friction clutches. Through these clutches the power is distributed to the various points of the crane for moving the bridge, moving the lifting trolleys, and hoisting the load.

In addition to the trolleys for heavy work a quick hoist is used for lifting small loads under 100 lbs. This is operated by a 5-H.P. Wenstrom motor, series-wound and reversible, which is controlled from the main platform of the crane. This motor and drum move backward and forward with the trolley, the current being taken to the motor through a cable which hangs at the side of the bridge, from small wheels arranged for the purpose.

Both cranes move the entire length of the shop. The carriages or trucks carrying the bridges run on steel rails weighing 135 lbs. per yard, which were rolled especially for this plant. They work very smoothly and easily and have proved a great saving of time and work, as a locomotive or a boiler can be moved the whole length of the shop in five minutes. For all lighter work one of the 40-H.P. motors is run, the other one being started only in case of necessity.

The current for the motors is furnished by two Westinghouse constant-potential, compound-wound generators, each of 80,000 Watt capacity, and each driven by a Westinghouse compound engine. The current is conveyed to the motors on the crane by an overhead double-trolley line, each trolley wire being ½ in. in diameter and carefully insulated. The current is taken from the wires by Wheeler trolleys, each having four wheels, and each crane has two trolleys.

The electrical work was done by the Equitable Engineering & Construction Company of Philadelphia, and the whole plant has served its purpose very well thus far. In addition to the two traveling cranes there are in use in the shop four jib cranes run by electrical motors. These cranes have a capacity of from 5 to 10 tons, and each one is run by a 5-H.P. Wenstrom motor.



ARMORED CRUISER "NEW YORK," FOR THE UNITED STATES NAVY.

THE UNITED STATES NAVY.

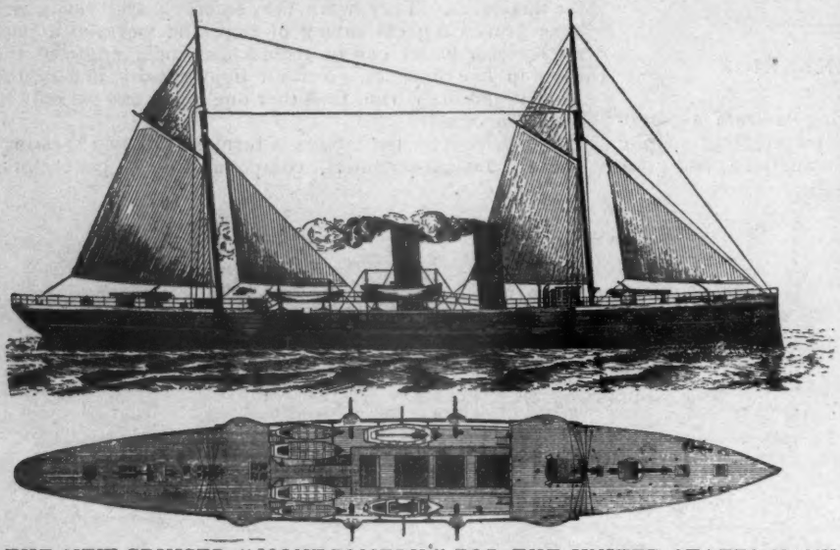
THE armored cruiser *New York* was successfully launched from the Cramp yards in Philadelphia, December 2, the launch being witnessed by a large and distinguished company. The *New York* is the second ship of this type undertaken for the Navy—the *Maine* being the first—and is the largest ship yet launched for the Navy.

The new ship is 380 ft. 6 in. in length on the water-line, 64 ft. beam, and will have, when completed, a displacement of 8,150 tons, and a mean draft of 23 ft. 3 in. She

will be exceeded in displacement by the three battle-ships now under construction, and in length by cruisers Nos. 12 and 13, but is a very powerful ship in size and armament. She is expected to reach a speed of 20 knots an hour.

The main battery consists of six 8-in. breech-loading rifles and twelve 4-in. rapid-fire guns; the secondary battery of 12 smaller rapid-fire guns, four 37-mm. (1.46-in.) revolving cannon, and four machine guns.

The hull is protected by a vertical armor-belt over the machinery space, and by a steel protective deck from 2½ to 6 in. thick, extending from stem to stern. Within the armor-belt and above the protective deck a coffer-dam 3½ ft. wide extends the whole length of the ship, filled with cellulose.



THE NEW CRUISER "MONTGOMERY," FOR THE UNITED STATES NAVY.

The 8-in. guns will be carried in barbettes with 10-in. armor, which will protect the carriages, platforms and loading positions; over the guns will be shields 7 in. thick. The ammunition hoists and spaces below the heavy gun-mounts will have cone-shaped armor 5 in. thick. The 4-in. guns will have segmental shields of 4-in. plate, and the armor of the conning-tower will be 7½ in. thick.

This ship has twin screws and four engines, two on each shaft, so arranged that the forward engines can be uncoupled and only the after engines used when cruising at slow speed. The engines are of the vertical, inverted cylinder, direct-acting, triple-expansion type, the cylinders being 32 in., 46 in. and 70 in. in diameter, with 42 in. stroke. The valves are all piston valves, driven by link motions. The bedplates are of cast steel, and the engine framing consists of cast steel inverted Y-frames, two to each cylinder. There is one condenser and one auxiliary condenser to each engine, and the circulating and air pumps are worked by independent engines.

Steam is furnished by six double-ended boilers, of the horizontal return fire-tube type, each 15 ft. 3 in. in diameter and 21 ft. 3 in. long, and each having eight corrugated furnace flues 3 ft. 3 in. inside diameter. There are also two single-ended auxiliary boilers, each 10 ft. in diameter and 8 ft. 6 in. long, and each having two corrugated furnaces 2 ft. 9 in. inside diameters. All the boilers are built for 160 lbs. working pressure.

For forced draft there are six blowers—three to each fire-room—for the main boilers, and one blower to each auxiliary boiler.

It will be seen that this ship differs from all the other cruisers in having four engines, of which two will be sufficient for ordinary cruising, the others to be used only when high speed is required. These engines are expected to develop 16,000 H.P., and to propel the ship at a speed of 20 knots an hour.

The coal carried at normal displacement will be 500 tons; but the ship will be able to carry 1,500 tons altogether; this will give her a cruising endurance of 13,000 knots, at a speed of 10 knots an hour.

THE LAUNCH OF THE "MONTGOMERY."

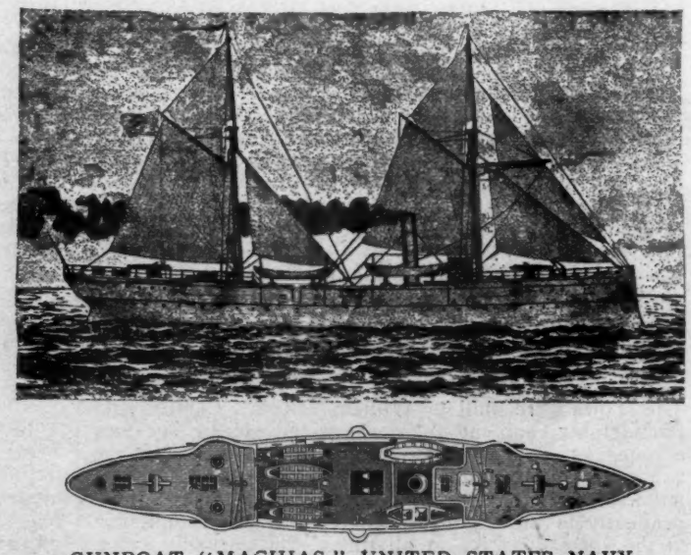
Cruiser No. 9, which was launched from the yard of the Columbian Iron Works in Baltimore, Md., December 7, has been named *Montgomery*; she is a sister ship to the *Detroit*, which was described in the December number of the JOURNAL. For convenience of reference the brief description is here repeated, and a sketch of the ship given, which is essentially the same as that of the *Detroit*, differing only in the point of view.

The *Montgomery* is an unarmored steel cruiser 257 ft. in length and 37 ft. beam, and will have a mean draft of 14 ft. 6 in. The machinery is covered by a protective deck varying from ⅜ in. to ⅞ in. in thickness, and is further protected by a coffer-dam filled with cellulose and by the arrangement of the coal bunkers. Her displacement with a normal load is 2,000 tons.

The ship has twin screws, each driven by a triple-expansion engine of the vertical inverted type, having cylinders 26½ in., 39 in. and 63 in. in diameter and 26 in. stroke. The engines are expected to develop 5,400 H.P., with 160 lbs. boiler pressure and running at 185 revolutions. There are three double-ended boilers 11 ft. 8 in. in diameter and 18 ft. 8 in. long, and two single-ended boilers 11 ft. 8 in. in diameter and 9 ft. 2 in. long. The forced draft is on the closed ash-pit system.

The coal bunkers will hold 200 tons, and extra bunkers are provided so that 435 tons can be carried. With the latter supply the cruising range is 8,950 knots at a 10-knot speed. The contract speed with full power is 17 knots an hour.

The armament carried will consist of two 6-in. and eight 4-in. rapid-fire guns. The secondary battery will include four 6-pdr. and four 3-pdr. rapid-fire guns and two 37 mm. (1.46 in.) revolving cannon. There will also be six torpedo tubes.



GUNBOAT "MACHIAS," UNITED STATES NAVY.

LAUNCH OF THE "MACHIAS."

The third launch of the month was of gunboat No. 5, which was successfully launched from the yard of the Bath

Iron Works, at Bath, Me., on December 8, 1891, in the presence of a large assembly.

This ship, which has been named the *Machias*, is one of two vessels the construction of which was authorized by Congress in 1889. The contract was let to the Bath Iron Works in April, 1890, that company having bid for both ships; the contract price was $637,000. No. 6, which will be a duplicate of No. 5, will be launched early in the year, and both ships will be ready for service early in the summer of 1892.

The *Machias* is a steel gunboat of the following dimensions: Length on load water-line, 190 ft.; beam, 32 ft.; mean draft, 12 ft.; displacement, 1,050 tons. She has no armor; but the engines and magazines are protected by coffer-dams filled with woodite, and by the arrangement of the coal-bunkers.

There are two screws, each driven by a vertical triple-expansion engine, with cylinders 15 in., 25 in. and 34 in. in diameter and 24 in. stroke. There are four boilers, each 10 ft. in diameter and 17 ft. 6 in. long. The contract speed is 14 knots an hour. The coal capacity is 250 tons, which will give a cruising limit of 2,450 knots at 14-knot speed and 4,700 knots at 10-knot speed.

The *Machias* will carry a heavy armament for her size. The main battery will consist of eight 4-in. rapid-fire guns, one mounted on the forecastle; one on the poop deck; three on each side in sponsons on the main deck. These six guns will each have an arc of about 70° of fire. The secondary battery will include four 6-pdr. and two 1-pdr. rapid-fire guns and two Gatling guns.

There will be two masts, with fore-and-aft rig, and about 6,500 sq. ft. of canvas can be spread. The ship will have steam steering gear, electric lights and other modern fittings, and very comfortable quarters for officers and crew.

With her light draft and heavy battery of rapid-fire guns, the *Machias* and her sister ship will be very useful vessels on some of the foreign stations, as in China and South America, and might be also of use as auxiliaries in coast defense.

"WAS IT IRON OR STEEL?"

By H. DeB. Parsons, M.E.

THE following is in brief the testimony of the author in a suit brought to recover an alleged overpayment of duties by Messrs. Matthew Farris, *et als*, against Daniel Magone, Collector of the Port of New York, because the Government had classified the imported metal in question as steel, and had collected duties in accordance with that classification. It is of interest as showing the methods adopted to decide the question.

On October 3, 1890, the author was retained by the Government to examine a sample of the importation, and as his report sustained the position already taken, he was called as an expert witness in the case which came to trial before Judge Lacombe and a jury in the United States Circuit Court, April 15, 16, 17 and 20, 1891. Mr. James T. Van Rensselaer, Assistant District-Attorney, conducted the case for the defendant, in whose favor the suit was decided.

Commercial steel may be considered as an alloy of iron, and is made by different processes, all of which may be classified under one of three different heads: Process of decarbonization, process of cementation and the direct process.

These processes were then described in brief.

The elements that compose steel are numerous, consisting chiefly of iron, carbon, manganese, phosphorus, sulphur, silicon, chronium and many others of minor importance. Carbon is generally found between the limits of 0.2 and 2 per cent., and is either in a free or combined state. The other elements occur, in general, between the following maximum limits:

Manganese,	from 0 to 1.0	per cent.
Phosphorus,	from 0 to 0.1	" "
Sulphur,	from 0 to 0.2	" "
Silicon,	from 0 to 0.5	" "

The characteristics peculiar to steel are chiefly its tensile strength, its property of hardening when heated and suddenly cooled, and its capability of being forged. Its structure is granular, and in general the more the steel is worked the finer and more homogeneous its structure. A coarse granular structure is often found in steel made by some direct process from the ores which has been little worked. Steel belongs midway between wrought iron and cast iron, and these three grades of "the irons," as they are sometimes called, have no defined lines of distinction. In general, however, the cast irons will chill, the steels temper, while the wrought irons will not harden at all.

The characteristics of steel were then defined in detail; and in reply to a question, the author then described the physical tests made by him on a sample of the imported metal. These tests were made as follows:

The sample of metal was about 3 in. long by 2 in. wide and 1⅛ in. thick, broken off from a large piece or slab.

Fig. 5.

Fig. 2. Fig. 1. Fig. 3.

The top and bottom sides were oxidized, while the fractured edges showed a crystalline structure, and in appearance it resembled either a forge iron, a white cast iron or a steel. The original piece was photographed, as also the result of each different experiment, and these photographs as well as the specimens were exhibited in court. The

Fig. 4.

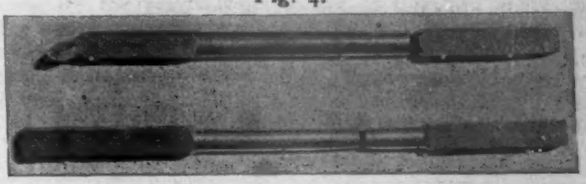


Fig. 6.

original sample was cut in two parts on a planer, the chuck and tool being cleaned with ether to remove all foreign particles, and the chips were saved for analysis. This analysis, as well as the others given below, was made by Mr. J. H. Wainwright, Ph.B., and are given in the table in column *A*. One of the pieces was kept to be exhibited in court, as a sample of the original piece; this is shown in fig. 1. The other piece was forged at a red heat into a bar ⅜ in. square by about 12 in. long. The metal forged very well indeed, and thus proved itself not to be a cast iron. During the forging two chips were cut off, one being plunged into water while red hot; this is shown in fig. 2; the other being annealed in air, and shown in fig. 3. The former was tempered to a high degree of hardness, such as steel alone will take, while the latter remained quite soft and easily filed.

The bar was then broken cold by nicking with a cold chisel and striking with a hammer, the fracture showing a fine granular structure, as is seen in steel. A piece of the best Stubbs tool steel was procured and forged down to a square bar similar to the one of the imported metal, and in like manner was broken cold. The fracture of the Stubbs steel showed a corresponding fine granular structure.

One end of the bar of the imported metal was then heated to a white heat until it began to burn, and was then cooled in air. It did not crumble readily under the hammer, proving again it could not be cast iron. The bar

was then broken into two pieces, one of which was put into a lathe and turned into a test piece, shown in fig. 4. The other was tested for the temper tests, and is shown in fig. 5. This latter piece tempered very well indeed in water, showing the colors beautifully; one end being hard enough to easily scratch glass, while the other was quite soft. To further prove its degrees of hardness, it was tried with a fine triangular file. The file took hold very readily on the soft end, but before the hard end was reached, the file not only refused to mark the bar, but actually lost its edge. These temper tests prove that the metal was not wrought or forged iron, but steel of a high grade.

In tuning the test piece the chips were saved, which gave the analysis in column *B* of the table. It will be noticed that the process of heating and forging did not materially alter the composition of the metal.

A similar test piece was also made from the forged bar of Stubbs steel, fig. 6, the analysis of which is also given in the table in column *C* by way of comparison. These test pieces were then broken on a standardized Riehlé Brothers' testing machine, with the following results:

TENSILE TESTS.

	Imported.	"Stubbs."
Length between marks	3.000 in.	3.000 in.
Diameter	0.368 in.	0.350 in.
Area in square inches	0.1064 sq. in.	0.09621 sq. in.
Breaking stress, actual	13,770 lbs.	11,200 lbs.
Strength, per sq. in.	129,420 lbs.	116,410 lbs.
Extension, actual	0.05 in.	0.19 in.
" percentage	1.7 per cent.	6.3 per cent.

CHEMICAL ANALYSIS.

	A, Imported.	*B*, Imported.	*C*, Stubbs.
Carbon	1.261	1.208	1.492
Silicon	0.049	0.048	0.086
Sulphur	0.011	0.011	0.020
Phosphorus	0.034	0.034	0.022
Manganese	0.469	0.474	0.094
Iron (by diff.)	98.176	98.225	98.286
	100.000	100.000	100.000

It will be seen that the sample of imported metal was over 11 per cent. stronger than the Stubbs steel. The small percentage of elongation was to be expected with such great tensile strength.

In order to test more thoroughly the character of the imported metal, a "side" tool was made on the end of the larger test piece. With this tool there was cut in a lathe a piece of unannealed octagonal tool steel. Although the cut was excessively heavy, far greater than is ever done in practice, and the metal operated on a hard unannealed tool steel, the tool did not lose its cutting edge, but stood up to its work as only the best of hard steel could do. The cut was made dry, and that is the reason the turning was not smoother.

From the above experiments, it was the author's opinion that the sample of imported metal was a high grade of steel; that it was steel because it not only had the chemical composition of steel, but had all its physical characteristics. It forged readily; it tempered well at a low heat, and took all the degrees of hardness peculiar only to steel; it had a very high tensile strength; it had the fine granular structure of steel, and lastly it made a very excellent tool. It was termed a sample of steel, as it had al the distinguishing characteristics peculiar to steel; and, finally, it was undoubtedly steel, as its chemical and physical properties would not be consistent with either cast or wrought iron.

FIG. 1. TRIAL OF OCTOBER 31.

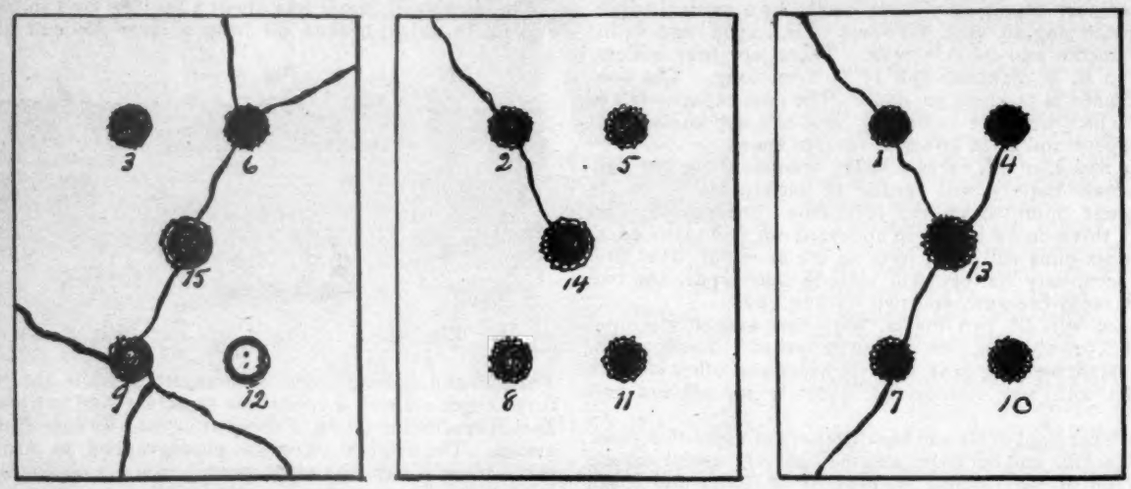


PLATE NO. 3. PLATE NO. 2. PLATE NO. 1.

THE TRIAL OF AMERICAN-MADE ARMOR-PLATE.

BY LIEUTENANT J. M. CALIFF, THIRD U. S. ARTILLERY.

AT the conclusion of the Annapolis armor tests last September, when the Schneider nickel plate so handsomely carried off the honors, it is not probable that the most enthusiastic believer in the skill and enterprise of American metal-workers supposed for a moment that within about a twelvemonth not one only, but at least two home-made plates would surpass the Creusot product, with one or two others giving it a close race for the mastery.

The trials took place on the new Naval Ordnance Proving Ground at Indian Head, Md., on October 31 and November 14 last, three plates being tested upon each occasion. These trials were to test the quality of American-made plate, to settle the questions of the value of nickel, of face-hardening and of the percentage of carbon to be employed, or, in other words, the hardness of the plates, and incidentally, the comparative resisting power of the hammered and rolled plate.

The competing firms were the Bethlehem Iron Company and Carnegie, Phipps & Company, of Pittsburgh, Pa. The Bethlehem plates were all forged under the hammer; the Pittsburgh plates were rolled. Each firm had its own method of tempering; both submitted plates of high and low carbon and those face-hardened by the Harvey process. In this process, it will be remembered, the face of the plate is exposed to the action of carbonaceous gases at high temperature, the back being protected meanwhile; the result being an exceedingly hard face, while the remainder of the plate retains its original toughness.

The plates tested were: No. 1, Bethlehem high-carbon (.30 of 1 per cent.) nickel steel. No. 2, Pittsburgh low-carbon (.24 of 1 per cent.) nickel steel. No. 3, Bethlehem low-carbon (.27 of 1 per cent.) all steel (Harvey). No. 4, Pittsburgh high-carbon (.40 of 1 per cent.) nickel steel. No. 5, Pittsburgh low-carbon (.25 of 1 per cent.) nickel steel (Harvey). No. 6, Bethlehem high-carbon (.35 of 1 per cent.) nickel steel (Harvey).

The first three of these plates were tested on October 31, the remainder on November 14. The plates were of the uniform dimensions of 6 ft. × 8 ft. × 10½ in., well backed and braced. The guns were the new 40-caliber 6-in. and a 35-caliber 8-in. rifle. With the 6-in. gun the charge was 42 lbs. brown powder; projectile, Holtzer steel, 100 lbs.; striking velocity, 2,075 foot-seconds; striking energy, 2,988 foot-tons, giving a calculated penetration in wrought iron of 13.2 in., or in steel of about 10.56 in. With the 8-in. gun the charge was 74½ lbs. of powder; projectile, Firminy steel, 210 lbs.; striking velocity, 1,850 foot-seconds; striking energy, 4,988 foot-tons, giving a calculated penetration in wrought iron of 14.74 in., or of about 11.80 in. in steel. Upon the last day's trial two Carpenter 250-lb. 8-in. shells were substituted for Firminy, but the charge was reduced sufficiently to make their striking energy about the same.

Comparing the results of these trials with those of last year, it will be noticed that the behavior of Plate No. 2 was almost identical with that of the Schneider nickel plate at Annapolis—both admitting of great penetration with little inclination to crack—although the former did have one unimportant crack. The all-steel French plate of last year broke into four pieces when taken from its backing; the only plate that failed to hold together this year was Plate No. 4, the lower left-hand corner becoming detached. The backing of the two plates placed at the head of the list was practically uninjured, while the two shots on Plate No. 6 produced only the faintest trace of a bulge.

FIG. 2. TRIAL OF NOVEMBER 14.

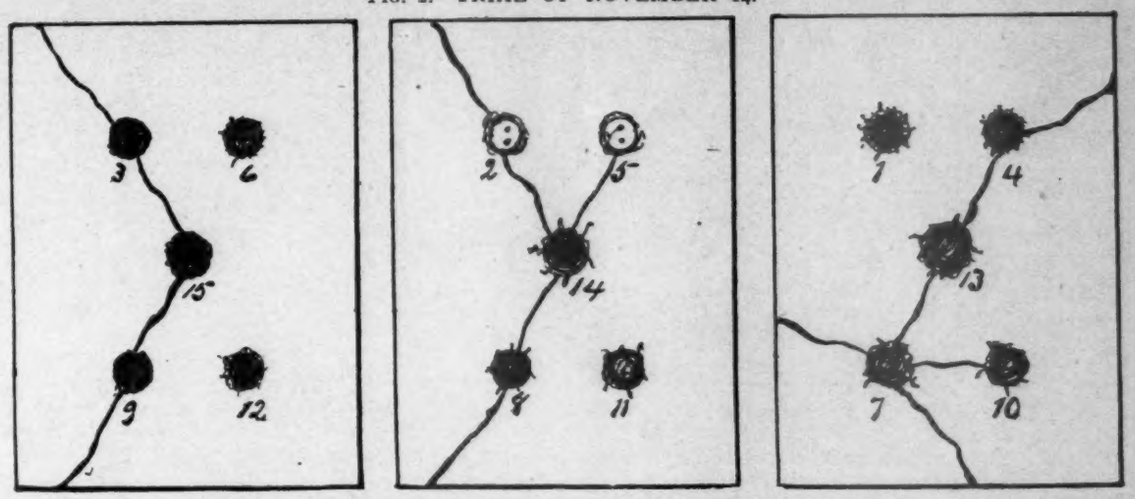


PLATE NO. 6. PLATE NO. 5. PLATE NO. 4.

In the matter of penetration it may be interesting to compare the results obtained in this regard from the Creusot nickel plate and the best Bethlehem plate just tested. Taking the shots in order, the penetrations were: Creusot, 1890—15.65 in., 15.15 in., 13.90 in., 13.90 in., 20.90 in.; Bethlehem, 1891—12 in., 5 in., 12.25 in., 5.50 in., 12.87 in. The weight of projectile and striking energy were identical.

The results may be arranged in tabular form as below:

TABLE I. TRIAL OF OCTOBER 31 (FIG. 1).

No. of Shot.	Character of Plate.	Penetration, inches.	Effect upon Projectile.	Effect upon Plate.
1	Bethlehem high carb. n'k'l, Plate No. 1.	13	Rebounded—uninjured.	Symmetrical burr, 1 in. in height, raised about shot-hole—no cracks.
4	" " " " " "	9	Broken into fragments.	Symmetrical burr, 1 in. in height, raised about shot-hole—no cracks.
7	" " " " " "	13	Rebounded—uninjured.	Symmetrical burr, 1 in. in height, raised about shot-hole—no cracks.
10	" " " " " "	10¾	Broken up.	Symmetrical burr, 1 in. in height, raised about shot-hole—no cracks.
13	" " " " " " (8-in. proj.)	16½	Rebounded.	Cracked as shown in cut. Crack to upper left-hand corner, through and ½ in. wide at top of plate.
2	Pittsburgh low carb. n'k'l, Plate No. 2.	29⅝	Embedded in plate.	Burr raised as in shot No. 1. Proj. 19 in. into backing.
5	" " " " " "	26¾	" " "	Almost entire length of shell in backing.
8	" " " " " "	20¾	" " "	Half length of shell in backing.
11	" " " " " "	13½	Broken up.	Burr raised as before—no cracks.
14	" " " " " " (8-in. proj.)	22	Embedded in plate.	Base of shell 1 in. below face of plate, appearance of plate as shown.
3	Bethlehem low carb. all steel, Pl. No. 3.	8	Broken—point in plate.	Irregular burr raised, fragments of which broken off.
6	" " " " " "	8	Broken up.	Upward crack from shot-hole to edge of plate 3 in. in depth—burr as before, larger fragments broken off
9	" " " " " "	27½	Embedded in plate.	Base of proj. sunk over 9 in. below surface of plate.
12	" " " " " "	6	Embedded ⅝ length in plate.	Two cracks started from shot-hole No. 9 toward lower right-hand corner and to bottom of plate.
15	" " " " " " (8-in. proj.	43½	Embedded in plate.	Badly cracked, as shown. Plate practically destroyed.

TABLE II. TRIAL OF NOVEMBER 14 (FIG. 2).

No. of Shot.	Character of Plate.	Penetration, inches.	Effect upon Projectile.	Effect upon Plate.
1	Pittsburgh high carb. n'k'l, Plate No. 4.	12⅛	Rebounded—uninjured.	Irregular burr about shot-hole, fragments broken off.
4	" " " " " "	10¾	Rebounded—broken up.	Burr as before—short radial cracks.
7	" " " " " "	12	" " "	Crack from shot-hole to bottom of plate.
10	" " " " " "	11⅜	" " "	Existing crack widened, new crack started from shot-hole through No. 7 to edge of plate.
13	" " " " " " (8-in. proj.)	9⅝	" badly upset.	Existing cracks greatly widened, additional cracks as shown, metal chipped off around shot-hole.
2	Pittsburgh low car. n'k'l, face-hardened, Harvey process, Plate No. 5.	14½	Embedded in plate.	Short radial cracks through burr, metal chipped off.
5	Pittsburgh low car. n'k'l, face-hardened, Harvey process, Plate No. 5.	14¾	" " "	" " " " " " " "
8	Pittsburgh low car. n'k'l, face-hardened, Harvey process, Plate No. 5.	9¾	Rebounded. Set up 2".	" " " " " " " "
11	Pittsburgh low car. n'k'l, face-hardened, Harvey process, Plate No. 5.	20¾	Embedded in plate.	Base of shell 3" below face of plate, other conditions as before.
14	Pittsburgh low car. n'k'l, face-hardened, Harvey process, Pl. No. 5 (8-in. proj.)	15¾	Rebounded—broken up.	Cracked in both directions, as shown. Short radial cracks about shot-hole.
3	Bethlehem high car. n'k'l, face-hardened, Harvey process, Plate No. 6.	12	Rebounded—badly broken up.	But little burr, metal chipped off about shot-hole. No bulge.
6	Bethlehem high car. n'k'l, face-hardened, Harvey process, Plate No. 6.	5	Point in plate, remainder in fragments.	Point of projectile apparently welded to plate. No cracks, burr or bulge.
9	Bethlehem high car. n'k'l, face-hardened, Harvey process, Plate No. 6.	12¼	Rebounded, intact.	Number of small radial cracks about shot-hole.
12	Bethlehem high car. n'k'l, face-hardened, Harvey process, Plate No. 6.	5½	As in No. 6.	Exactly as in shot No. 6.
15	Bethlehem high car. n'k'l, face-hard., Harvey process, Pl. No. 6 (8-in. proj.).	12⅞	Rebounded, slightly chipped.	Cracks through left-hand shot-holes, as shown.

The report of the official Board places the plates in the following order of merit:

1. Bethlehem high-carbon nickel-steel (Harvey) plate (No. 6); 2. Bethlehem high-carbon nickel-steel plate (No. 1); 3. Pittsburgh high-carbon nickel-steel plate (No. 4); 4. Pittsburgh low-carbon nickel-steel (Harvey) plate (No. 5); 5. Pittsburgh low-carbon nickel-steel plate (No. 2); 6. Bethlehem low-carbon all-steel (Harvey) plate (No. 3).

The result of these trials has been to confirm very emphatically the claims made on behalf of nickel after last year's experiments. The value of face-hardening was also demonstrated; but as at present applied, the Harvey process is an expensive method, and difficult to employ. Improvement in this last respect is hoped for in the direction of being able to apply it to the ingot before it is hammered or rolled.

A glance at the tables will show a great want of uniformity in the penetration of like projectiles in the same plate; noticeably so in Plate No. 3 of the first trial and No. 6 of the last. This is explained upon the ground that in the tempering process the different parts of the plate received a different degree of temper, owing to defective methods employed. In Plate No. 6 it may be said that only one-half of the plate was properly treated.

From an economical point of view, perhaps the most important question settled by these trials is that rolled armor-plate approaches very nearly in resisting qualities the hammered product. The latter process possesses the advantage of not only being cheaper, but as requiring much less time for its fabrication.

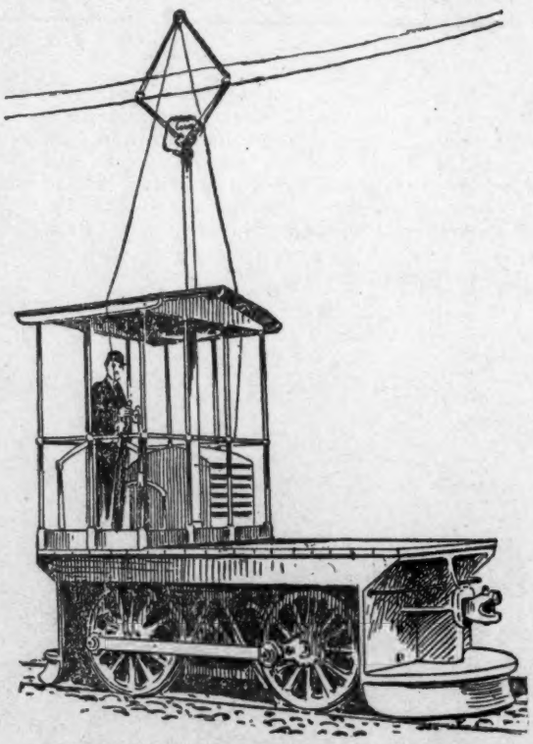
It is understood that the orders for the armor-plate for the vessels now building will be divided between the Bethlehem and Pittsburgh firms—the first coming from Bethlehem for the *Monterey*.

It is surely a matter for congratulation that, in this the first trial of American-made steel plate, it should have proved itself, under a test that has never been exceeded in severity, the superior of any armor ever yet brought to the trial ground.

An Electric Freight Locomotive.

THE accompanying illustrations show the first large electric freight locomotive built in this country, just completed by the Thomson-Houston Electric Company at the factory at Lynn, Mass. Fig. 1 is a general view, and fig. 2 shows the running gear with the platform removed.

This machine is designed to pull and shift freight cars at Whitinsville. The Whitin Machine Company, for which the machine has been made, proposes to carry merchandise back



THOMSON-HOUSTON ELECTRIC [LOCOMOTIVE.]

and forth from the railroad station to the works, a distance of 1½ miles, by electric power.

The locomotive is equipped with a powerful motor of the "G" type of the Thomson-Houston Electric Company.

The power is communicated from the armature to the rear axle by double reduction gearing, and from the rear axle to the forward one by parallel rods.

The locomotive is built in a square form, with a platform for carrying loads, and with cow-catchers and draw-bars at each end.

The power is to be furnished by a large generator located at the works of the machine company and conveyed over a trolley wire, from which it is taken by means of a universal trolley bar attached to the locomotive.

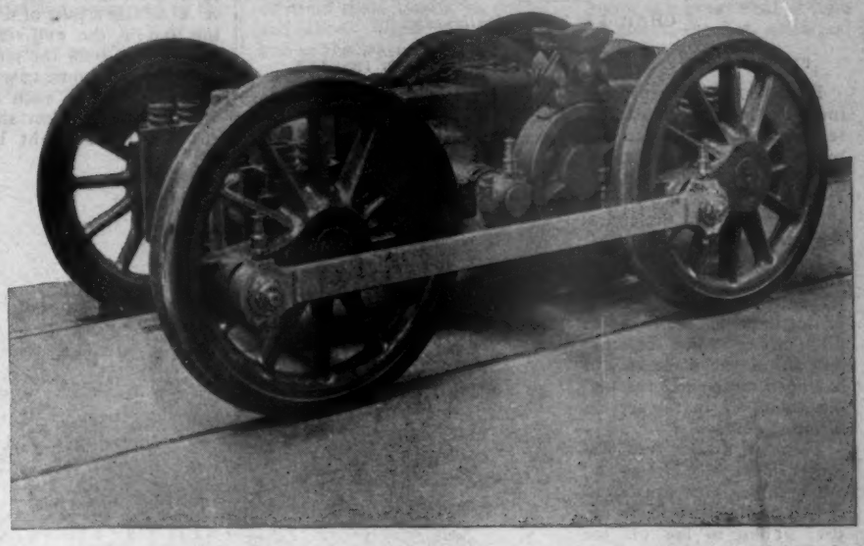
The total weight of the locomotive is 43,000 lbs., and the speed when delivering 100 H.P. at the draw bar is about five miles per hour. This is sufficient to pull a train of six to eight heavily loaded freight cars on a level, or an aggregate of 200 to 300 tons.

The construction of the locomotive is of the strongest kind. The motor has wrought-iron field magnets, which are belted to magnetic yokes of iron. One of these yokes carries the gearings which support that end of the motor on the axle, while the other yoke is spring supported from the other axle.

This keeps the gears always in line, and meshing correctly with each other, and at the same time provides considerable spring support for the motor.

The gearing is of aluminum bronze pinions and cast wrought-iron gear-wheels. This gearing runs in gear cases, in which a plentiful supply of grease is placed. This decreases the noise, friction and wear.

On the intermediate shaft is keyed a mitis-iron brake drum, which is covered with wood lagging. It is embraced by two half bands of steel, tightened upon it by means of the brake drum lever situated in the operating stand.



TRUCK OF THOMSON-HOUSTON LOCOMOTIVE.

The driving wheels are 42 in. in diameter and are steel tired.

The frame consists of two heavy side plates, in which are located the main axle bearings.

The heavy cast-iron end-plates, on which are cast the cow-catchers, are bolted to the side plates by through bolts.

The operating platform is at one end of the main platform, and is railed in and covered with a protecting roof. On this platform are the levers for operating the controlling mechanism, the brake and the sand boxes.

The universal trolley bar extends upward from the locomotive at this place.

The controlling mechanism consists of two large rheostats of the Thomson-Houston railroad type. These are so arranged with their contact shoes that no reversing switch is needed.

The operator so stands that he always faces in the direction in which the locomotive is to go, and being in this position, he pushes the rheostat lever from him to make the locomotive go forward, and pulls it toward him to make it go backward.

A positive center lock is provided, so that in turning the current off there is no danger of passing the neutral point on the rheostat, and so reversing the locomotive with the current on.

When the operator stands in the above-mentioned position he pushes the brake lever from him in order to apply the brake.

The bands are so arranged on the brake drum that the friction tends to tighten them up more upon the wood lagging, and so assists the operator.

A combined main switch, lightning arrester and fuse box is placed within easy reach of the man, so that he can instantly shut the current off from the locomotive by a single movement of the hand.

The construction of the motor is of the most rigid and waterproof kind, the field spools having their wire enclosed and entirely sewed up in canvas bags, which are covered with a heavy coating of waterproof paint.

Some data on the locomotive are as follows: Voltage of locomotive, 500 volts; power, 100 H.P.; speed on level track, with full load, 5 miles per hour; speed reduction between armature and axle, 1 to 25. The engine is of standard 4 ft. 8½ in. gauge; the drivers are 42 in. in diameter, and the wheel-base 6 ft. 4 in. The length of the platform is 12 ft. 7⅛ in., and the length over all, at the pilots, is 15 ft. 9⅛ in. The width over all is 7 ft. 0¼ in. The height of the platform above the rail is 4 ft. 4 in. The weight of the locomotive complete, except the trolley-pole, is 42,525 lbs.; the motor weighs 5,400 lbs. It is furnished with sand-boxes and with spring draw-bars of the link-and-pin type.

The machine was designed and built under the supervision of Mr. J. P. B. Fiske, at the company's Lynn factory.

Foreign Naval Note.

Some trials recently made at Shoeburyness of compound armor-plates having the face hardened by a new process invented by Captain Tresidder have, it is stated, given better results than have been heretofore attained. The projectiles used were Palliser chilled shot, Holtzer shell and Hadfield steel shot. The new process seems to have hardened the plate so that the liability of the projectiles to break up without penetrating is increased; but it does not seem to have removed any of the inherent defects of the compound plate as shown in previous trials.

Of the projectiles used, the Hadfield steel showed the best results, and the Palliser chilled shot the poorest. The Holtzer shell did well, but hardly as well as the Hadfield.

New Double-Screw Ferry-Boats.

The double-screw ferry-boat seems to be finding favor on the Hudson River, and will probably in time replace entirely the old paddle-wheel type. The latest examples are the *Bremen* and the *Hamburg*, now nearly completed for the Hoboken Land & Improvement Company's ferry between Hoboken and New York. The *Bergen*, of that line, was the first double-screw boat, and in the new boats the same type has been followed, with the addition of the upper saloon; in this following the example of the Pennsylvania Railroad Company, as shown in the *Cincinnati*, which was described last month.

The hulls of the new boats are of steel, and have been built at the yard of T. S. Marvel & Company, at Newburg, N. Y. The dimensions are: Length over all, 222 ft.; length on water-line, 218 ft. 6 in.; breadth over guards, 62 ft.; beam of hull, 35 ft.; depth, 17 ft.; draft, 11 ft. As stated above, the boats are double-decked. The upper saloon is 97 ft. long by 36 ft. wide and 10 ft. high. It has a promenade hood extending all around it, butting against the pilot houses, giving the whole a pleasing appearance. The lower saloons are 157 ft. long, with an average width of 15 ft.; height, 13 ft. A double stairway leads from each lower saloon to the upper one. The total seating capacity in each boat is 450 persons.

Instead of one triple-expansion engine, like the *Bergen*, these boats have each two compound engines of the vertical inverted type. The engines have been built by the W. & A. Fletcher Company, of New York. The cylinders are 20 in. and 36 in. in diameter and 28 in. stroke. The cranks in each engine are set opposite to each other, and when the engines are coupled the center line of the cranks in one is at right angles with the other, so that on the shaft there are four cranks 90° apart. The shaft runs the whole length of the boat, with a propeller on each end. The air and circulating pumps are driven by an independent compound engine, with cylinders 7 in. and 14 in. in diameter and 16 in. stroke. There are two air-pumps, 17½ in. × 14 in. cylinders, and one double-acting circulating pump 17 in. × 16 in. cylinder.

Steam is furnished by two boilers, each 9 ft. 1 in. in diameter and 21 ft. long; each has two corrugated furnaces 44 in. in diameter, the total grate surface being 100 sq. ft. The working pressure will be 125 lbs. in regular service.

THE ESSENTIALS OF MECHANICAL DRAWING.

By M. N. Forney.

(Copyright, 1890, by M. N. Forney.)

(*Continued from page 570, Vol. LXV.*)

CHAPTER XIII.—(*Continued.*)

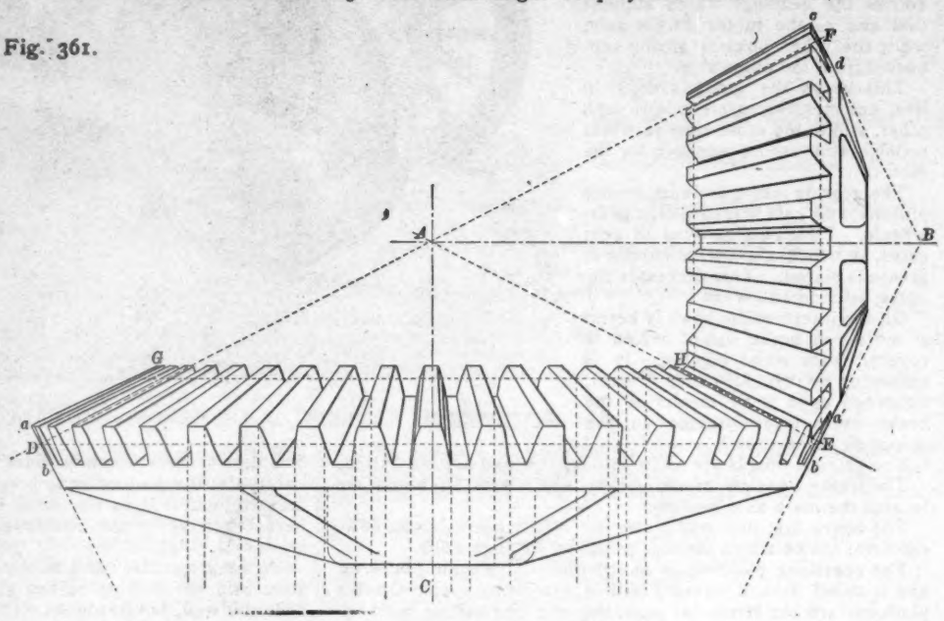
[PROJECTION OF A BEVEL WHEEL AND PINION IN GEAR.

Figs. 360 to 364 represent a bevel wheel with 40 teeth geared into a pinion with 20 teeth, the pitch being 2 in. Fig. 360 represents a section through the center of the wheel and of the pinion; fig. 361 a side view; fig. 362 a plan, and fig. 363 a view looking at the side of the wheel and at the end of the pinion.

Let *A B* and *A C*, fig. 360, be the axes of the pinion and wheel, and *D E* and *F E* the projections of their major pitch circles. The teeth are laid off in the same way as has been described for laying them off in the section of miter gears.

To draw a side view, the center lines, pitch circles and pitch cones are drawn as shown by dotted lines in fig. 361. Then to lay off the teeth it will be necessary first to draw a plan, fig. 362, and from this project the teeth in the same way as was explained for drawing a miter gear. If the different views are not on the same sheet or not in such relation to each other as to permit the projection of the teeth from the plan to other views, as is the case with figs. 362 and 363, these lines—as *a' a*, *E D* and *b' b*, fig. 362, corresponding to *a a'*, *D E* and *b b'* of fig. 361—should be drawn in pencil, and the points of the teeth can then be projected to them, as indicated by dotted lines in fig. 362. Then take the distance of each point of intersection, as 1, 1, 2, 2, 3, 3, etc., of the projection lines with *a a'*, *D E* and *b b'*, from the center line *K A B* with a pair of dividers, and transfer it to the corresponding line in the end view, fig. 363. It is of course more convenient to draw the plan immediately above or below the end view; but in some cases it is not possible to place the views in such relation to each other. This is the case with the three views of the pinion shown in figs. 361, 362 and 363. In fig. 361 the teeth might be projected from the end view of

Fig. 361.



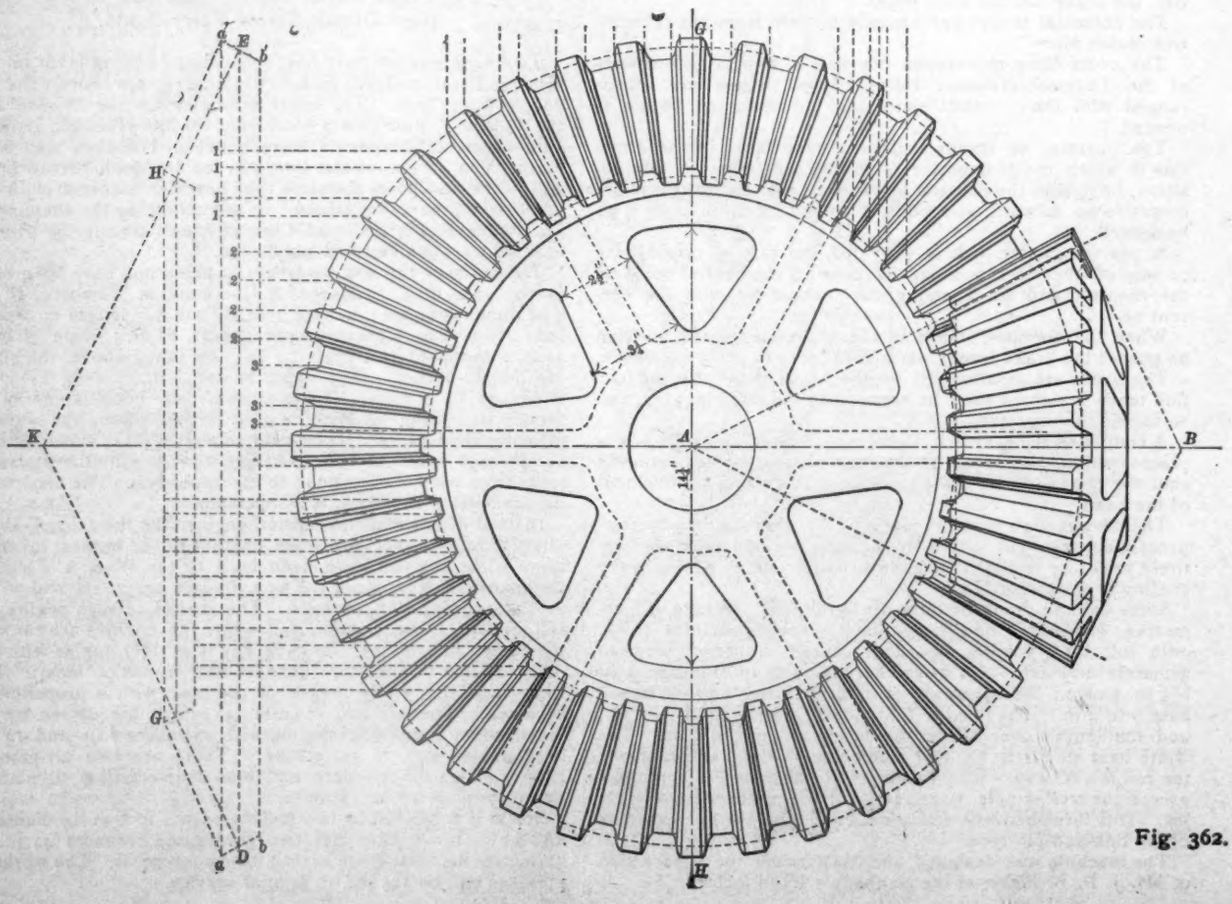


Fig. 362.

the pinion shown in fig. 363. Obviously, if the plan is placed in such a position that the teeth of the pinion can be projected from its end view to both fig. 361 and fig. 363, then it would be impossible to project the teeth of the wheel from its plan to the side view, fig. 361. Therefore a plan or side view (or possibly both) of the pinion should be drawn in pencil in fig. 363, as indicated by dotted lines, to which the teeth can be projected, and the points thus determined can then be transferred to the appropriate views with a pair of dividers.

In drawing a wheel and pinion in gear with each other it will be difficult to represent the teeth in the side view, fig. 361, which mesh into each other in their proper relation without an end view which will show this. It is therefore best to draw a back view of the pinion showing the teeth of the pinion and wheel, which are engaged together as represented in fig. 364, as a guide in drawing the side view. They may be laid down in pencil and rubbed out when the side view is inked in.

The student will find that drawing a pair of bevel wheels correctly is quite a difficult problem, which requires a good deal of skill. The examples given should be drawn either half or full size, as a beginner will find it less difficult to draw such wheels on a large scale than it is to represent them as small as they are shown in the engravings.

In practice drawings of bevel wheels are seldom completed in all their details, as doing so involves a great deal of time and labor. Ordinarily only the pitch cones, the rim, arms and hub of the wheel and a few teeth are shown.

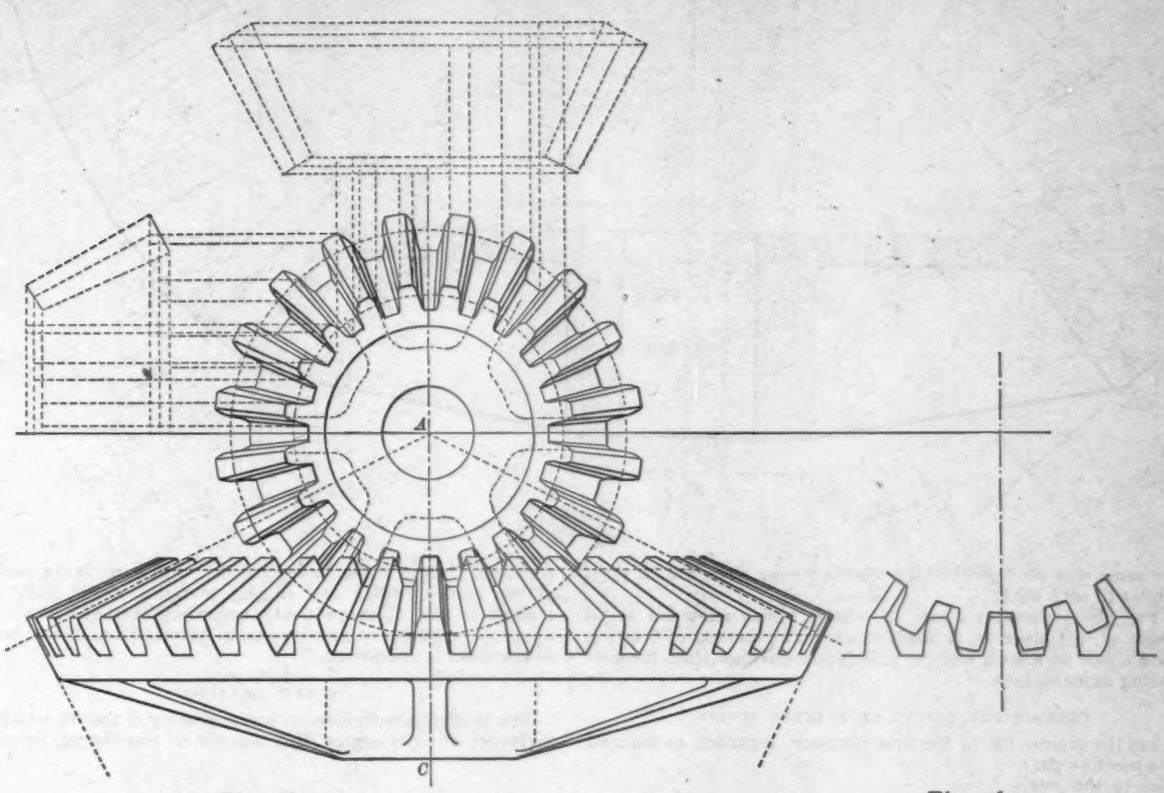


Fig. 363.

Fig. 364.

Fig. 365 represents a section of a bevel wheel and pinion whose axes, $S K$ and $S B$, stand at an angle of 60 degrees to each other instead of being at right angles, as in the previous examples. The wheel has 48 teeth and the pinion 24 of 2-in. pitch. The diameter of the major pitch circle of the wheel is, therefore, $30\frac{9}{16}$, and that of the pinion $15\frac{3}{8}$ in. To draw the wheels, first lay down their axes or center lines $S K$ and $S B$ at the required angle $K S B$ to each other. Then lay off on each side of $S K$ distances $C D$ and $C E =$ half of the pitch diameter, and draw lines $a b$ and $c d$ parallel to $S K$. Do the same thing for the pinion, and draw $e f$ and $g h$. Then from E, the point of intersection, draw lines $E D$ perpendicular to $S K$ and $E F$ perpendicular to $S B$; then $E D$ and $E F$ will be the major pitch diameters from which the primitive pitch cones $D S E$ and $E S F$ may be drawn. The remaining parts of the wheel may then be laid off in

Fig. 360.

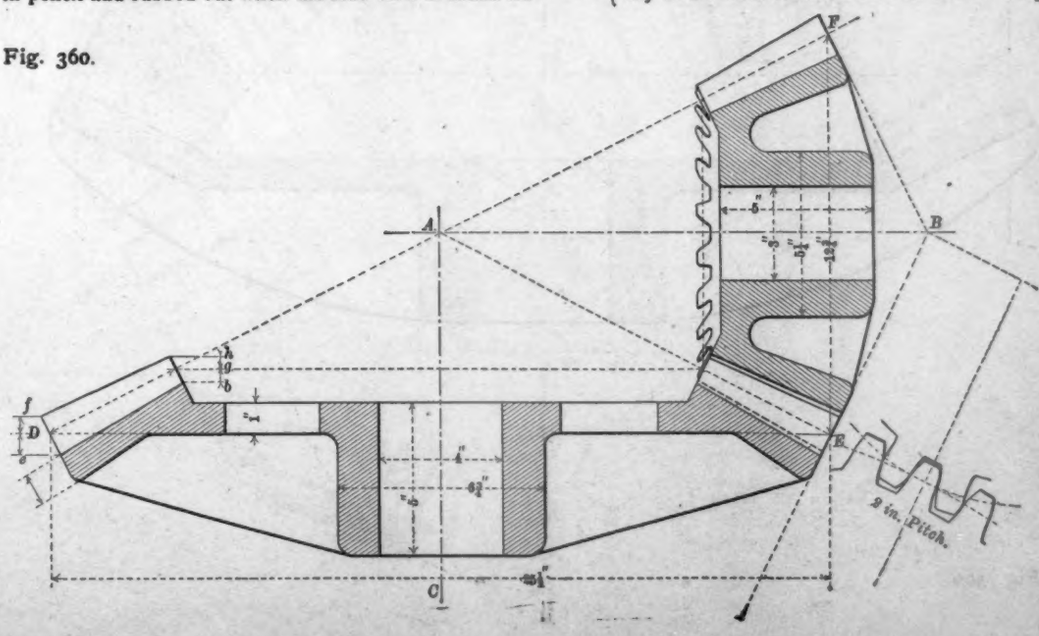
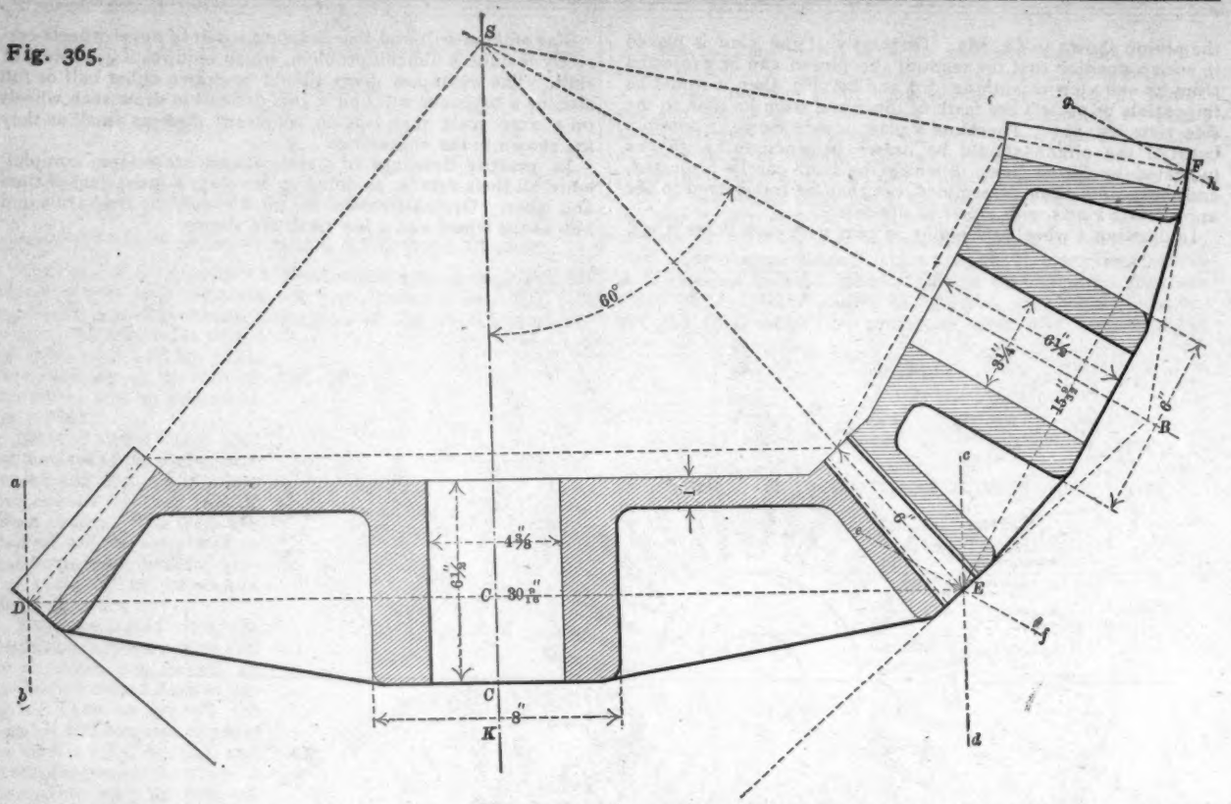


Fig. 365.



the same way as described for wheels whose axes are at right angles to each other.

Fig. 366 represents a pair of wheels whose axes are at an angle of 135 degrees to each other. The method of drawing such a pair of wheels will be sufficiently obvious from the preceding explanations.

OBLIQUE PROJECTION OF A BEVEL PINION.*

Let the pinion be, in the first instance, regarded as situated in a position parallel to the vertical plane, and construct accordingly its projections at figs. 367 and 368. Then transfer the edge view to fig. 370, giving to the axis $S\,O'$ the required inclination to a vertical or horizontal line; and project upon the horizontal center line $A\,B$ of fig. 369 the vertices O, O', S of the various cones employed to determine the direction and construction of the teeth. The teeth themselves are then to be projected upon fig. 370 in the manner already described in reference to spur wheels, observing that all their rectilinear edges converge toward the point S, while the outlines of the planes (which are, in this instance, radial lines) tend toward O and O' respectively, according as they are situated upon the exterior or interior cones, between which the length of the teeth is comprised.

SCREW GEARING.

The most common form of screw gearing is that in which the shafts are at right angles, and a screw of one thread, or some-

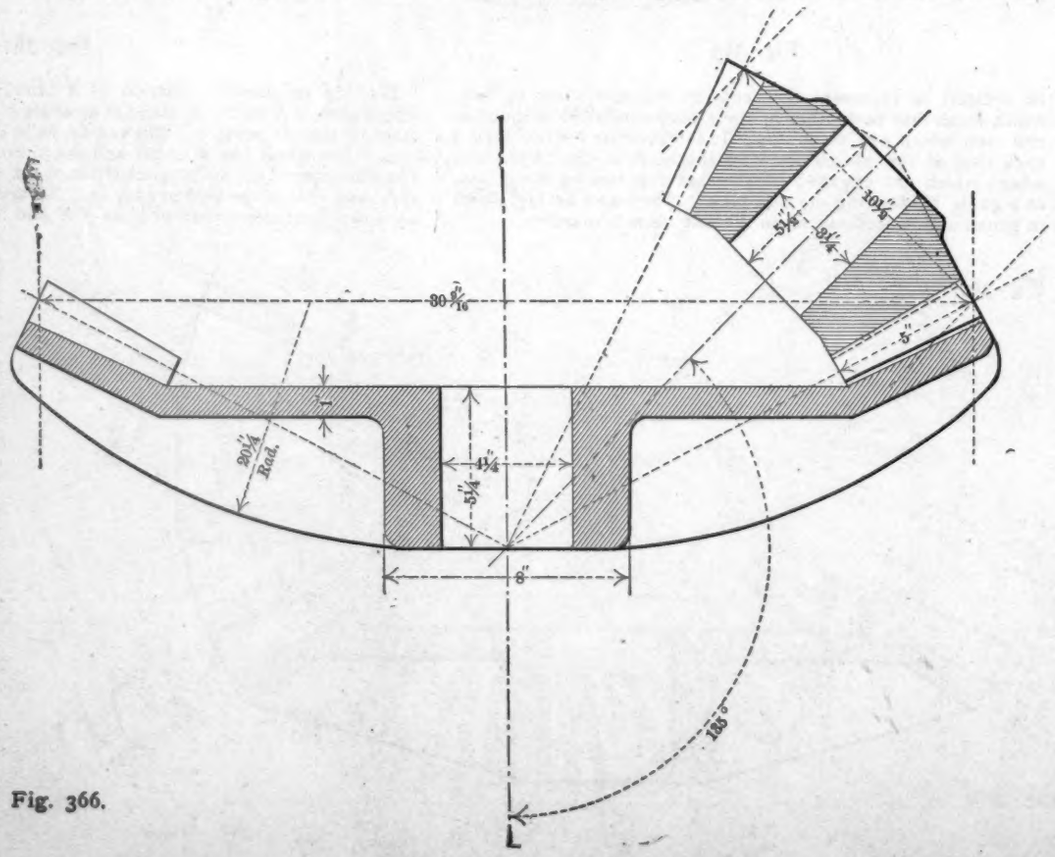
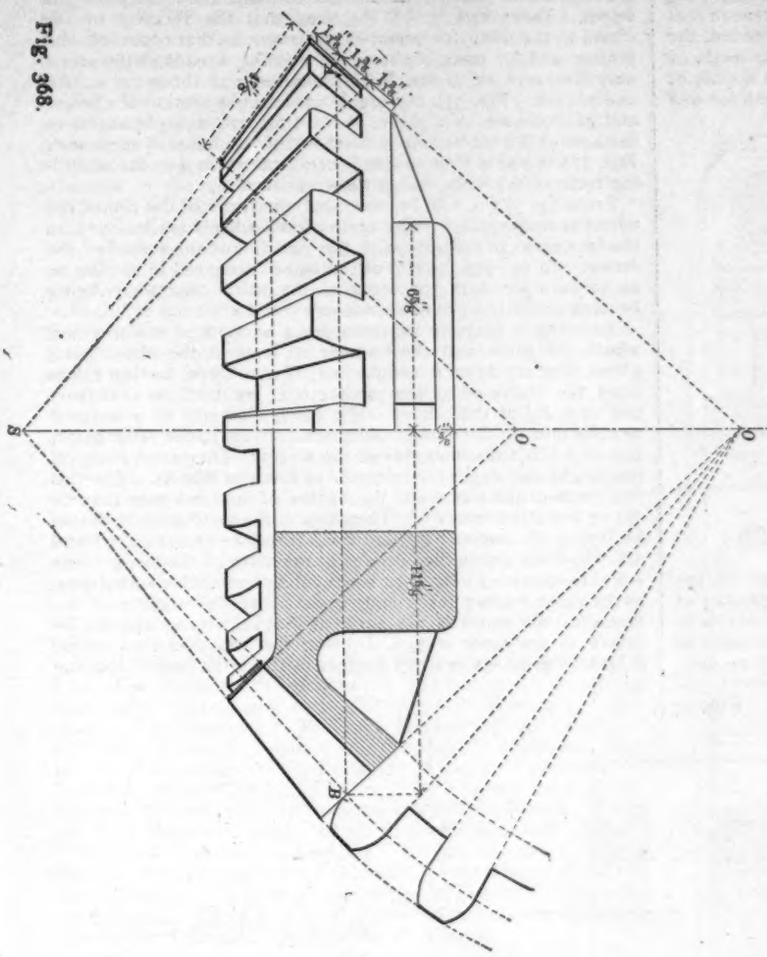


Fig. 366.

* The following explanation and the engravings illustrating it are taken from the "Engineer and Machinists' Drawing-Book."


A
B
S
O
O
1⅛"
⅝"
⅝"
⅝

times of two or three threads, works with a wheel of many teeth. Then the screw is often called a *worm* and the wheel a *worm wheel*. With this arrangement a great difference in the velocity of the screw and wheel is obtained, for the reason that for one revolution of the screw, if it is single threaded, the wheel is moved a distance equal to the pitch of its teeth, or equal to one tooth and its space. If the screw is double or treble threaded the wheel is moved two or three teeth for one

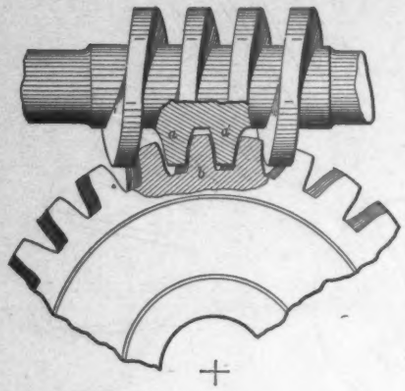


Fig. 371.

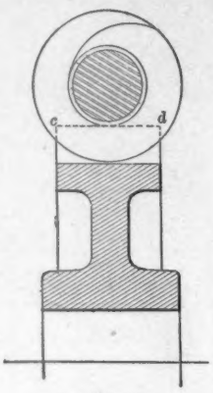


Fig. 372.

revolution of the worm. A much greater difference in the force which can be exerted is possible with screw gearing of given dimensions than with a spur wheel. A spur wheel, to produce the same difference would have to be at least ten times as large as a worm wheel. Screw gearing is commonly so constructed that the worm or screw will drive the wheel, but the wheel will not drive the worm. This is often advantageous, as in a windlass for hoisting weights and other forms of mechanism, because the gearing remains stationary in any position it may be in after being moved.

If a worm wheel is geared into a single-threaded screw the pitch of the teeth of the wheel is equal to the pitch of the thread of the screw. If the latter is double or treble threaded its pitch is two or three times that of the teeth of the wheel. Single-threaded screws will be considered first.

Figs. 371 and 372* show a wheel and single-threaded worm. A part of the threads at *a a'* and the adjoining teeth of the wheel are shown in section on a line through the center of the worm. From this it will be seen that the relation of the wheel to tne worm or screw is the same as that of a rack and pinion, and the teeth of the wheel and the threads of the screw may therefore be drawn in the same way as those for a rack and pinion. Fig. 373 represents a transverse section of a worm and gear drawn on a plane, *A B*, of fig. 374, at right angles to the axis of the worm and parallel and through that of the wheel. Fig. 374 is a side view of the wheel, the worm and the adjoining teeth of the wheel being shown in section.

From fig. 372 it will be seen that the form of the rim of the wheel is rectangular. The teeth of the wheels are inclined on the face so as to coincide with the position of the thread of the screw. In fig. 373 the rim of the wheel is curved in section so as to coincide with the form of the worm, the teeth being beveled on their sides as shown at *a b* and *a' b'*.

To make a drawing representing a section of a worm and wheel, the pitch and the number of teeth of the wheel being given, first lay down a center line, *G H*. Then, having calculated the diameter of the pitch circle, lay it off on *G H* from the axis *I J* of the wheel. The pitch diameter of a worm is usually four or five times the pitch. From *p*, the pitch point, lay off *p o* half the diameter of the worm. Then from *p* lay off the height and depth of the teeth, as for spur wheels. The tips and roots of the screw and the section of the teeth may then be drawn from the center *o*. The sides of the teeth may be drawn by laying off angles *b o p* and *b' o p* from the center *o*; *o b* and *o b'* will then define the outlines of the sides of the teeth. The wheel represented in fig. 374 has involute teeth, which are drawn in the same way as for a spur wheel; and the section of the thread of the screw is the same as that for a rack, and can be drawn in the same way, *C D* being the line of action, which is laid off at an angle of 23 degrees to the pitch line *E F* of the screw, and is drawn through the pitch point *P*. The base circle of the wheel is drawn tangent to the line of action, and in this instance coincides with the root circle of the teeth. The form of the sides of the threads are straight lines perpendicular to *C D*.

Fig. 373.

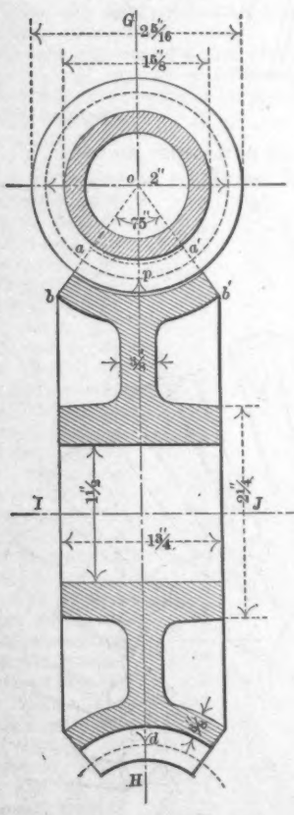
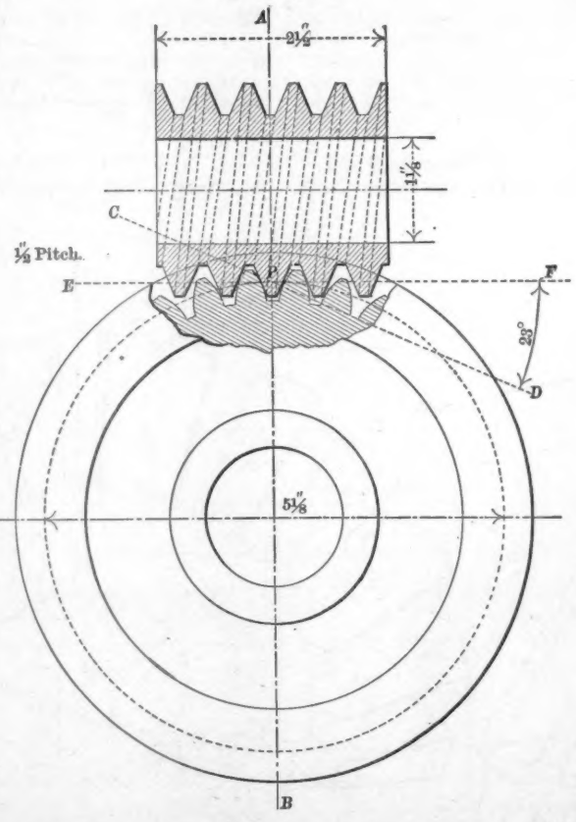


Fig. 374.



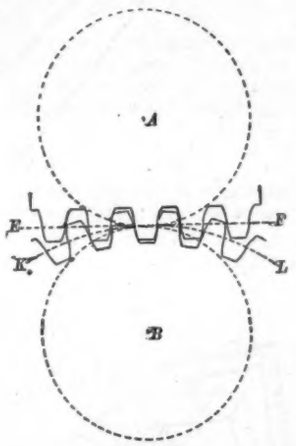


Fig. 375.

If cycloidal teeth are used, the outlines of the teeth of the wheel are described by points in generating circles *A* and *B*, fig. 375, rolling within and without the pitch circle *K L* of the wheel, and the outline of the thread of the worm by the same circles rolling on its pitch line, *E F*.

It has been pointed out that if the section of the teeth of a worm wheel on a plane through and parallel with their axes, be made like that of a spur wheel of the same radius and pitch, and the threads of the worm like the teeth of a rack suitable for working with such a spur wheel, the worm and wheel will gear correctly together so far as contact in that plane is concerned. It has commonly been assumed and acted on that all radial sections of the worm threads must be of the form so fixed, which

* From Unwin's "Elements of Machine Design."

is right and necessary; and also that all sections of the worm wheel teeth on sections parallel to the plane referred to should be similar, which is unnecessary, and gives a bad form of worm wheel teeth. If that proceeding is adopted, the worm wheel teeth become merely twisted spur wheel teeth, which only touch the worm teeth at a point in the median plane. The point of contact moves from root to point of the teeth along the intersection of the median plane with the tooth; the rest of the surface of the tooth is never in contact at all, and the whole of the pressure and wear is concentrated at a single line on the face of the tooth. It is probably in part due to this imperfect construction of the worm wheel that screw gearing owes its bad reputation for friction and rapid wear.*

For these reasons the teeth of screw gears are now cut with a hob, which is shown in fig. 375, being a steel piece on which the thread is cut with the same tool with which the threads of the worm are cut. The steel threads are then grooved longitudinally to the axis of the screw and hardened. The teeth of the wheel are first cut as nearly to the finished form as practicable. The hob and wheel are then mounted upon shafts and the hob is placed in mesh with the wheel. The hob is now made to rotate, and is dropped deeper into the wheel at each revolution of the wheel until the teeth are finished. The hob usually drives the worm wheel, but sometimes the machine on which the teeth are cut is arranged to drive both the hob and the wheel. Teeth cut in this way are counterparts of the thread of the worm, and consequently have more wearing surface and last longer than those which do not conform to the shape of the screw which drives them. Tools and machines of this kind are manufactured by the Brown & Sharpe Manufacturing Company, of Providence, R. I.†

Those who wish to study the subject of gearing and extend their information concerning it may find some or all of the following books useful:

Weisbach's "Mechanics of Engineering and Machinery;" Professor Willis's "Principles of Mechanism;" Professor Rankine's "Machinery and Mill Work;" Moseley's "Mechanics of Engineering;" Professor MacCord's "Kinematics;" Beale's "Practical Treatise on Gearing;" Professor Reuleaux's "Konstrukture;" Professor Klein's "Elements of Machine Design;" "Mill Gearing," by Thomas Box; "Elementary Mechanism," by Professors Stahl and Woods; "Elements of Machine Design," by W. C. Unwin (eleventh edition); "Practical Treatise on Gearing," by the Brown & Sharpe Manufacturing Company; "Odontics, or the Theory and Practice of the Teeth of Gears," by George B. Grant; "A Treatise on Toothed Gearing," by I. H. Cromwell; "Senior Course in Mechanical Drawing," by William H. Thorne.

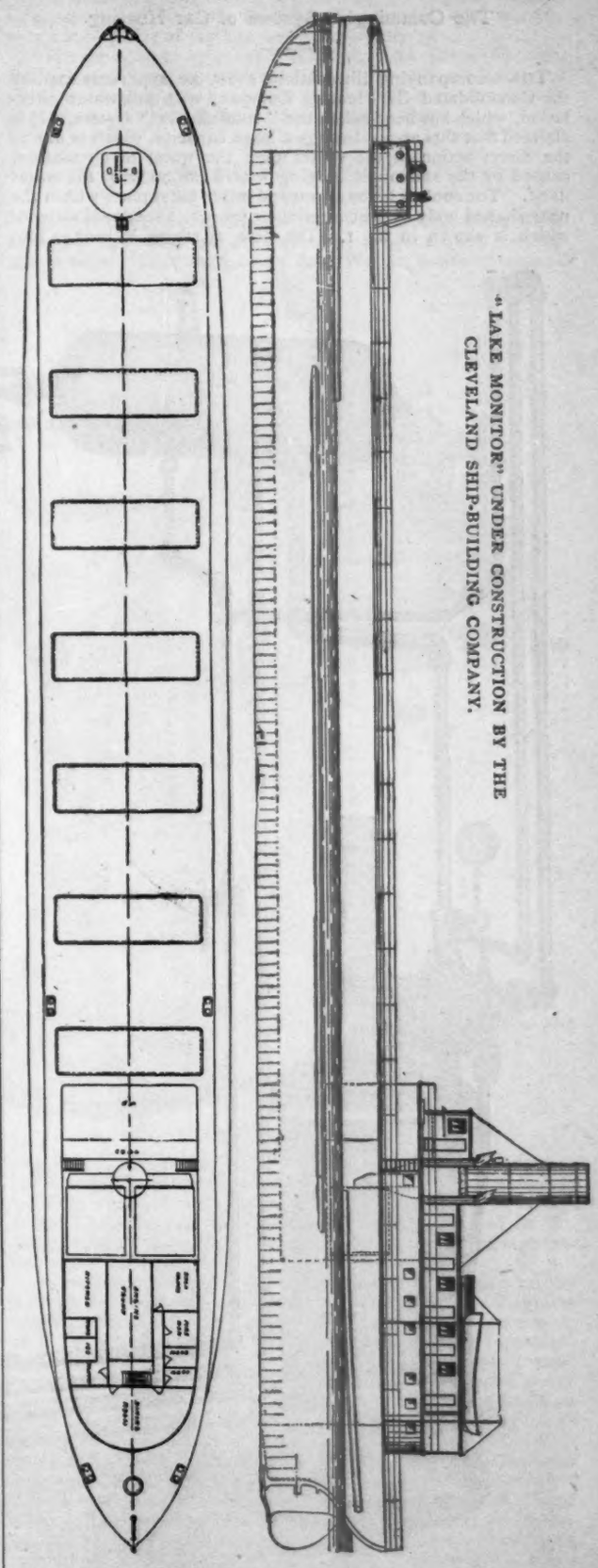
Lake Monitors.

(From the Cleveland *Marine Review*.)

In the contracts let a few days ago to the Cleveland Ship Building Company, by Mr. J. S. Fay, Jr., of the Lake Superior Iron Company, for two steel boats styled "Lake Monitors," another wide departure from the ordinary lake freight carrier is recorded, and the *Review* presents in the accompanying engravings the main features of the plans for the new boats. In brief it may be said that the monitor, as introduced by the Cleveland Company, will have an upper or outside deck with rounded sides and no lower deck, and will have but one bulkhead, the collision bulkhead forward. The familiar pilot-house and quarters for officers forward, as well as the turtle-back now common to lake steamers, will all be dispensed with, and in their stead a simple turret will be built for the windlass and for steering purposes in the rivers or during fine weather.

A reduction in cost as compared with the present type of steel vessel and increased carrying capacity are main features in the construction of the monitors, and there is little doubt that more of them will be contracted for before the opening of another season.

In the plans presented here it will be noticed that the bow is somewhat cut away. This was at the request of the owners, who look to speed being improved by such a bow, but the builders and others who favor the new type of boat prefer the ordinary straight bow and forefoot. The water bottom will be 4½ ft. deep, divided into six compartments, and the boat's sides will be strengthened by large belt frames. The main structure supporting pilot-house and cabins aft, and also containing quarters for some of the crew itself, will be built up of steel and will have no doors, the windows being small, high up and well secured. The boat will be the same size as the *Wawatam* and *Griffin* of the Lake Superior Iron Company's fleet—266 ft. long, 38 ft. beam, and 23 ft. hold—but is expected to carry as much as the first two boats built for the company, the *La Salle* and *Joliet*, the lines of which are not as fine as those of the *Wawatam* and *Griffin*. The engines and boilers will also be duplicates of those in the *Wawatam* and *Griffin*. The cylinders are 17 in., 29 in. and 43 in. in diameter and 36 in. stroke; the boilers are 11 ft. 6 in. in diameter and 12 ft. long. It was not at first intended to give the boats masts, but they will have two pole spars.



"LAKE MONITOR" UNDER CONSTRUCTION BY THE CLEVELAND SHIP-BUILDING COMPANY.

* This paragraph is from Unwin's "Elements of Machine Design."

† From "A Practical Treatise on Gearing," by the Brown & Sharpe Mfg. Co.

Manufactures.

The Commingler System of Car Heating.

THE accompanying illustrations show the apparatus used by the Consolidated Car-Heating Company with hot water circulation, which has been called the "commingler" system. It is claimed that this apparatus has a large capacity, which is due to the direct action of the steam upon the water of circulation, caused by the steam discharging within the body of the water itself. The contact of the steam and water takes place within the pear-shaped body of the commingler proper, a sectional view of which is shown in fig. 1. The flow of steam is broken into hundreds of small jets within a body of quartz pebbles, in such a manner as to silently force the water through the commingler after imparting to it the entire heat of the steam. It is claimed that by giving the proper form and direction to the steam jets within the commingler a forced as well as a gravity circulation is readily obtained, and it is the addition of this feature of forced circulation which enables the commingler to move the water through such large circuits. Any amount and distribution of piping that may be found desirable can therefore be made in a car, the capacity of the commingler being fully assured.

With this system, it is stated, there is no need of inspection, since the pipes are kept constantly full from the condensation. It can be readily applied to cars already equipped with hot-water apparatus, without the addition of new pipes. There is no danger of the system becoming "air-bound," as the overflow-pipe is connected to the air space within the expansion drum, and thus permits the compressed air to escape as the water of the circulating system expands. No air pressure can therefore be generated within the circulating pipes, and this doubtless accounts for the rapid circulation of water obtained with the improved commingler.

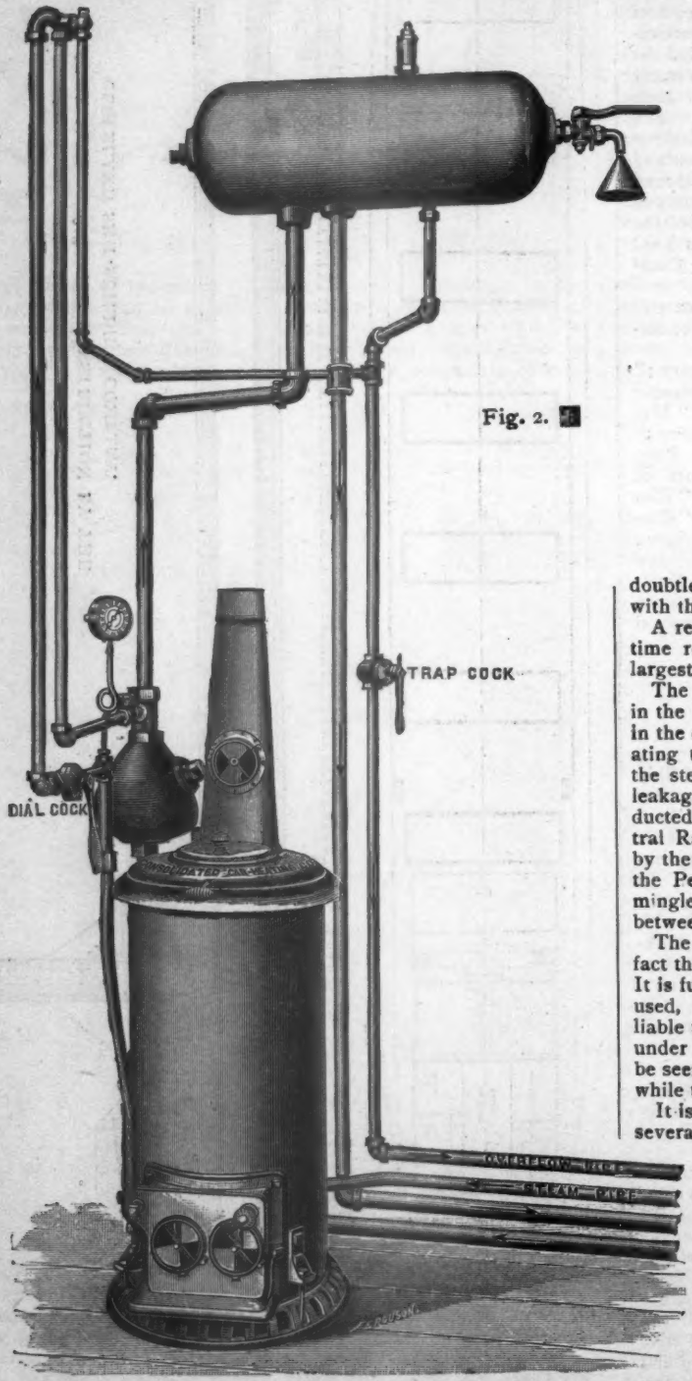
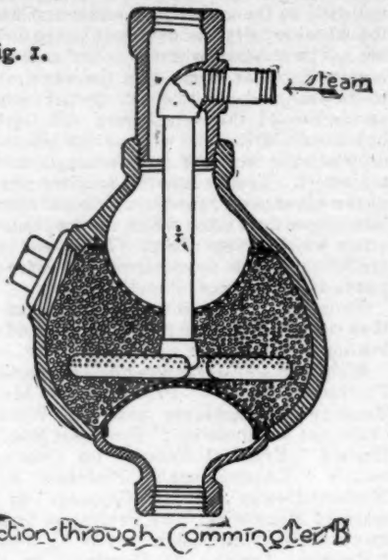


Fig. 2.

Fig. 1.



A record of tests presented states that 13 minutes is all the time required to obtain a complete circulation in even the largest cars.

The Consolidated Company states that 5 lbs. steam pressure in the train-pipe at the car is sufficient to heat the largest car in the coldest weather. The small pressure required for operating this system has practical value in increasing the life of the steam hose and in the increased safety and freedom from leakage at the connections between cars. Experiments conducted last year under the supervision of the New York Central Railroad showed that circulation was rapidly established by the commingler with 1¼ lbs. *of steam*, and in connection with the Pennsylvania Railroad return system the improved commingler has worked *in vacuum* with only a difference of 2 lbs. between the supply and return pipe.

The simplicity and ease of management is evident from the fact that the heating apparatus is controlled by only one valve. It is further simplified by the fact that no thermostatic trap is used, or any other device requiring frequent adjustment or liable to get out of order. No part of the apparatus is placed under the car where it is liable to freeze. Every part, as will be seen from fig. 2, is within the car where it can be reached while the train is in motion.

It is claimed that the heating capacity of the commingler is several times as great as that of any water heater, and it is capable of heating several cars by a single water circuit could they be properly connected together. As an instance of what can be done by the commingler, the circuit in the Whitehall tunnel ditches on the Delaware & Hudson Railroad, where one commingler circulates water through over 2,000 ft. of pipe and keeps the ditches free from ice in the coldest winter weather; and in the Albany Electric Railroad car-house there are some very long commingler circulations. It is also true that the amount of heat can be regulated to meet the requirements of the mildest weather where artificial heat is used.

It is the practice of railroads to store cars when not in service by placing them upon side tracks in yards or in car-houses, where in cold weather fire must be kept alive to prevent freezing of the water within the heating pipes. With the improved

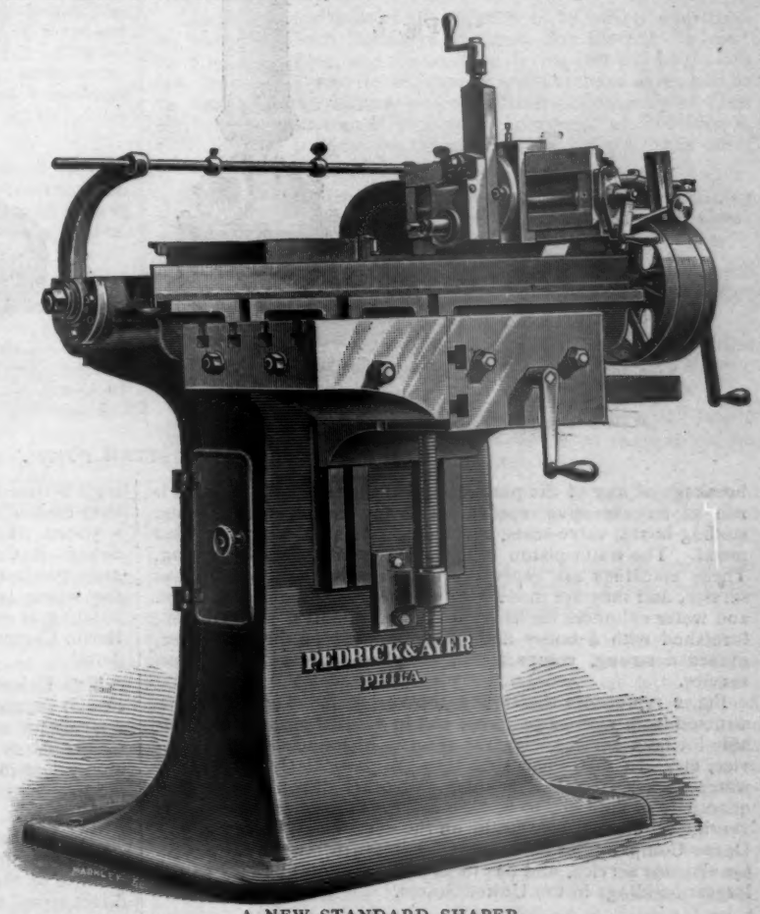
commingler system the drain cock can be opened and all pipes emptied before the car is laid up. The car then stands cold and without any danger to the empty pipes of the heating system. When the car is again brought into service, steam is turned into the pipes through the commingler, and the car is at first heated with direct steam. The drain cocks being closed, the water of condensation collects in the pipes until the system is filled with water and circulation automatically takes place. It is thus changed to a hot-water circulating system without the slightest care or attention on the part of the trainman having it in charge. In cold weather the pipes are filled within two hours after steam is turned on, and in the mean time the car has been heated with direct steam. Men having charge of cars when not in service will appreciate the great advantage thus obtained by the use of this apparatus.

These advantages are also found in the Consolidated Company's commingler storage system, which operates a water circulation without a water heater. The addition of the Consolidated automatic temperature regulator to the improved commingler or the commingler storage system makes a very complete equipment.

A Standard Shaper.

THE engraving herewith shows a new pattern of standard shaper made by the firm of Pedrick & Ayer, of Philadelphia.

This machine planes 12 in. wide and 30 in. long. It is a column machine, with an adjusting table 14½ in. long and 14½ in. wide, and an auxiliary table 11 in. long to bolt to same when a longer table is desired. This smaller table takes off and leaves an angle-plate to bolt long pieces against the table proper. This table is raised and lowered by a crank and screw with gibs, that carry it true in its upward and downward travel. The arm that travels and carries the cutting tool is designed to resist all cutting strains, and as true work is done at outer end of arm as close to the column. The tool slide has a downward feed by hand of 6 in., and a cross-feed by power; it is on a swivel base and angle work can be planed. The machine is driven by 12-in. pulleys and a 2-in. double-thread screw to the desired cutting speed, with a quick return 2½ times as fast as cutting speed. It has a locking device for holding tool slide solid while siding down or doing angular work. On the sliding head, in front of the operator, is a light cast-iron cover that forms a tool shelf for keeping the cutting tools; on the square tables there is another shelf for wrenches, oil-can, waste, etc., both being convenient and useful. This machine will do any kind of work that can be done on the ordinary ram shaper, and good true surface work also. It is particularly valuable for cutting key-ways in the center of long shafts. No chuck is required, as the column forms one side of a chuck, with jaws any desired depth, by lowering the table and using dogs and screw points and clamping against it.



A NEW STANDARD SHAPER.

The tool is always cutting at the same speed whether on long or short work. Not varying speed at all points of travel, as is the case with crank movements, the screw gives the tool a regular smooth cutting speed, producing the finest kind of a surface on all metals; water cuts on iron or steel can be taken, and as good results obtained as with water turning done on a lathe. The stroke of the machine can be altered while the machine is running and readily adjusted; very short cuts can be taken. The belt runs at high speed with positive cams operating the belt shifters, enabling the machine to work up to a line either way. All bearings are self-oiling and are bushed with bronze; all loose pulleys are self-oiling, with bronze bushings; counter-shaft has self-oiling bearings, and pulleys are nicely balanced. All gibs are of wedge pattern, forced, and held by two nuts or studs, allowing fine adjustment and all metal surface. The screw passes through two bronze nuts that are made in duplicate, and can be furnished at small cost.

The machine is so constructed that there is absolutely no spring to the arm when cutting out at the extreme end, as in this position the cutting tool hugs the guides tighter, and will not gauge in or raise up. This is a valuable tool for tool-room or general shop use. It is intended to take the place of a 25-in. or 30-in. old style shaper.

Brake Beam Patents.

THE following notice from Mr. George W. Payson, General Counsel of the Western Railroad Association, was recently sent out by order of the Executive Committee:

"We are advised by counsel that the claim above (National Brake Beam Company) is either wholly invalid, or, if valid at all, that it can only be sustained by giving it a construction so narrow as not to cover the Universal Brake Beam."

An Efficient Governor.

SOME tests were recently made of the efficiency of the Westinghouse compound engine governor, which showed remarkable results. They were made on a Westinghouse compound engine with 18 and 30 × 16-in. cylinders at the power-house of the Federal Street & Pleasant Valley Electric Street Railroad, by C. F. Scott of the Pittsburgh Laboratory of the Westinghouse Company. A special instrument was designed by Mr. Scott, reading to 0.01 per cent. variation of speed and registering every half second.

In electrical railroad work the variations in the load on the engines are very large and very sudden; but from diagrams taken on the special instrument used it appears that the engine changed but 1 per cent. each side of the neutral line representing the time of vibration of the pendulum through a total change of current equivalent to two-thirds of the rated power of the engine. From a similar curve illustrating the action of a governor which depends upon centrifugal force alone for its change of position, as tested by this instrument during moderate changes of load, it appears that after each new load the speed changed nearly 1 per cent. beyond the point at which it should have settled and gradually worked back to the proper place. This governor was perfectly free from obstructing devices; yet it is indicated plainly that adjustment did not even commence until the speed had changed considerably. However, this is not surprising when it is considered that it depends on this variation of speed for the force of adjustment. Indeed the record is not at all a bad one so far as centrifugal governors go, and the extra momentary change of speed would never be

noticed in the average service, but it would be wholly unfit for electric railway work.

In their new compound engine governor, the Westinghouse Machine Company disclaim broadly the originality of the principle of inertia in shaft governing, but insist that they have been the first to so successfully apply the principle, and exhibit in these tests the evidence of the degree of perfection they have secured by the application.

New Steam Pumps.

THE illustration herewith, fig. 1, shows a Deane special pattern pump designed for railroad and mining service. It is provided with a new patent lever valve motion which prevents

Fig. 1.

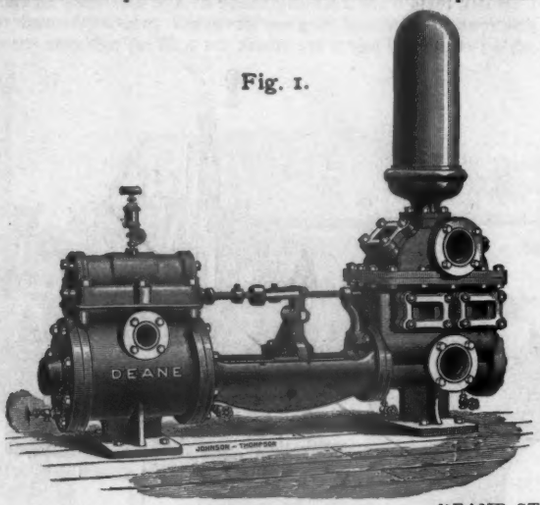
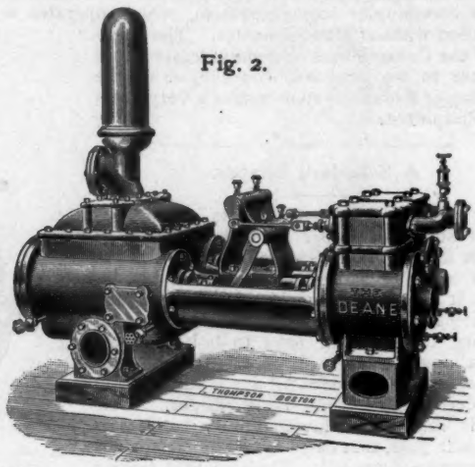


Fig. 2.



DEANE STEAM PUMPS.

breakage of any of the parts of the machine when the pump is run at an excessive speed. The piston-rod, water-piston, stuffing-boxes, valve-seats, covers and stems are of composition metal. The water-piston is fitted with patent fibrous packing. These machines are especially designed for hard, continuous service, and they are made with various combinations of steam and water cylinders for heavy or light pressures. This pump, furnished with a boiler and both mounted on the same base, makes a strong, compact and simple apparatus for station service.

Fig. 2 represents the Deane duplex pump. These are constructed from various patterns, and in various proportions suitable for tank service, elevator service, boiler feeding, fire service, etc. In the larger sizes they are particularly adapted for water-works, irrigation, sewage, and other duties where large quantities of fluid are to be handled, the uniform discharge preventing all unnecessary strain on the machine and pipes. The Deane Company has made quite a success of the duplex pumps for elevator service, and has them in operation in many of the largest buildings in the United States.

General Notes.

THE Engineer Department of the United States Army has awarded a contract for water-proofing and preserving the whole of the exterior and interior surfaces, magazines, etc., in fact, all the masonry work of the new gun and mortar batteries at Sandy Hook, New York Harbor, to the Brick & Stone Waterproofing Company, of New York, the work to be done by the Caffall process. This contract has been let after careful investigation, and may be considered as an expert testimony to the value of that process. These works from their position are exceptionally exposed to low temperatures and to the effect of storms.

THE Continental Iron Works, Brooklyn, have a number of orders for corrugated furnaces. The Lake Erie Boiler Works, of Buffalo, recently ordered six, to be used in the new boilers they are constructing for the Metropolitan Elevated Railroad of New York City. Other orders include eight extra large furnaces for J. T. Ryerson & Sons, to be used in the boilers of the new Masonic Temple in Chicago. It may be noted that the boilers of the new steamers of the Cunard Line now building at Fairfield, Scotland, will have 204 corrugated furnaces.

THE Lee Composite Manufacturing Company, New York, has lately received orders for its "slagphalt" paint for passenger car roofs from the New York, Susquehanna & Western, the New York, Ontario & Western, the Delaware & Hudson, the Philadelphia & Reading, the Boston & Albany, the New York, Providence & Boston, the South Carolina and other railroads. It is claimed that this paint will entirely prevent the cutting of roofs by cinders. This company's "Permanence" brand is especially adapted for the roofs of roundhouses and other railroad buildings, as it resists the action of acids and gases.

THE William Cramp & Sons Ship & Engine Company, of Philadelphia, is making extensive changes in its plant, and has placed the contract for a new boiler shop with the Berlin Iron Bridge Company, of East Berlin, Conn. This boiler shop will be constructed entirely of iron and will be composed of two parts, one part 55 ft. in width by 350 ft. in length, made very high between joints on account of moving large marine boilers over each other. This portion of the building is controlled by a 50-ton traveling crane which is to be furnished by William Sellers & Company, of Philadelphia. Connected with this main portion will be a wing 58 ft. wide by 370 ft. long, served the whole length by a 20-ton Sellers traveling crane. The building is constructed entirely of iron from the designs of the Berlin Company, and will be one of the most complete in every detail.

THE Delaware & Hudson Canal Company have adopted the Sewall coupler for all their passenger equipment, and these are now being applied. They have also determined to use the Consolidated Company's automatic temperature regulators on a good portion of their passenger equipment, this regulator having given excellent satisfaction upon the Albany & Troy Belt Line trains.

BY permission of Mr. H. Walter Webb, the Consolidated Car-Heating Company announces that it is equipping 106 new coaches of the New York Central with an improved system of direct steam heat. If this system gives the satisfaction expected, it is to be applied to all new cars built by the Central in 1892 and 1893, The New York Central have also given the Consolidated Company a considerable order for automatic temperature regulators, and these will be applied to cars which will be in service this winter.

THE Detroit Dry Dock Company, in Detroit, Mich., has closed a contract with the Berlin Iron Bridge Company, of East Berlin, Conn., for a new fire-proof machine shop to be used for their engine work. The plant will include two 20-ton electric cranes, and a large number of new tools of the latest patterns. The shop will be 201 × 66 ft., and will be 50 ft. high, the center being all in one story with the cranes so arranged that there will be 38 ft. clear space below them. Three galleries 28 ft. wide will extend the entire length of the main shop, two of them being intended for the lighter tools and the third for pattern work and storage. Plans are also being prepared for a boiler shop of the same style.

THE Cleveland Ship Building Company, Cleveland, O., is building the engines for the launch for the new lighthouse tender *Amaranth*. The boiler is of the Roberts safety water tube pattern.

THE Baldwin Locomotive Works are building 20 compound freight engines for the Philadelphia & Reading Railroad; 10 of them are consolidation engines with cylinders 14 and 24 in. in diameter, and the other 10 are of the same pattern with cylinders 13 in. and 22 in. in diameter, all of them being of the

Vauclain four-cylinder type. These works are also building for the Reading Road a compound locomotive with Wootten firebox, which is intended especially for speed. The cylinders are 13 and 22 in. in diameter, and the driving-wheels 6 ft. 6 in.; it is to be tried on the Bound Brook Line between New York and Philadelphia.

THE Cleveland City Forge & Iron Company, Cleveland, O., has recently been doing some very heavy work for the new cruisers. This Company made the rudder-frame for the *New York*, and has recently completed another weighing about 17 tons for Cruiser No. 12. Other heavy forgings recently made include an extra shaft for the steamer *Pilgrim* of the Fall River Line, which is 39 ft. 5 in. long, 27 in. in diameter, and weighs 68,200 lbs. finished. The forge has recently been increased in capacity by three new hammers, and an addition 69 ft. × 160 ft. is now under construction.

THE Frontier Iron Works, Detroit, are building four triple-expansion engines for new lake steamers. Two of these are duplicates, with cylinders 20 in., 32 in., and 54 in. by 42 in. stroke. The other two are 23 in., 37 in., and 62 in. in diameter and 44 in. stroke. They are also building two compound stationary engines with cylinders 9 in. and 17 in. by 38 in. stroke.

AT a recent meeting of stockholders of the Lawson Varnish Company, of Chicago, the capital stock was increased from $150,000 to $200,000. As a further indication of the growth and expansion of the business, they have, during the past year, enlarged their factory so that their capacity is doubled.

THE Buffalo Seal & Press Company, Buffalo, N. Y., has just moved into new quarters. This company is now manufacturing at the rate of 87,000,000,000 seals per year, and has lately increased its capacity by new special machinery. Besides supplying over 150 railroads, a contract for 7,000,000 seals for the United States Government was recently taken. The Company's seals have been adopted by the English, German, and Brazilian governments.

A NEW size of hydraulic jack has been added to the list of Watson & Stillman. It is specially designed for lifting parlor cars, has a broad steel base, is 37 in. in height, has 22 in. raise, and a lifting capacity of 30 tons.

THE St. Charles Car Company, St. Charles, Mo., has recently received orders for 200 furniture cars for the Missouri Pacific Railway and 500 box cars for the Atchison, Topeka & Santa Fé. In December the shops turned out 200 box cars for the Fairbanks Beef Company and 300 coal cars of 60,000 lbs. capacity, for the Texas & Pacific. In passenger work the Company has nearly completed 18 out of an order for 30 passenger cars for the Chicago, Burlington & Quincy, and has begun work on an order for the Lake Shore & Michigan Southern.

THE Toledo, St. Louis & Kansas City Railroad has just put in service between Toledo and St. Louis some new chair cars built for the road by the St. Charles Car Company. The interior decoration is very neat and tasteful, and the fitting and furnishing are very handsome; the interior finish is in mahogany throughout. The cars are 56 ft. long, and will seat 40 persons. At one end is the ladies' toilet-room, Baker heater and linen locker. At the other there is a handsome smoking-room, a lavatory for gentlemen, and a conveniently arranged buffet from which hot and cold refreshments can be served. A snug little sofa is fitted in front of the buffet, and the remaining space is given up to Scarritt reclining chairs with adjustable tables between.

Baltimore Notes.

NOTWITHSTANDING the difficulties encountered in tunneling under Howard Street, incident to sewers and quicksand, the construction of the Belt Railroad is being pushed forward rapidly. Howard Street is on a bed of quicksand. Two of the city sewers have been seriously damaged, and, owing to the nature of the soil, iron pipe will be substituted for the brick work in making repairs. It is thought that by September, 1892, the Belt Line will be in full operation, when the Baltimore & Ohio Railroad will abandon the Locust Point Ferry so far as passenger and freight traffic for points north of Baltimore are concerned.

THE South Baltimore Car Works, Curtis Bay, are building a sample 34-ft. inside measure lumber box car, of a lot of 1,000 cars to be operated by the West Virginia & Pittsburgh and the Baltimore & Ohio roads in the lumber trade; 500 of the cars will be built at Curtis Bay and 500 at Pullman.

THE West Virginia & Pittsburgh road, which is being extended from Bealington, W. Va., will connect with the Grafton & Greenbrier Railroad at Philippi, W. Va. The Grafton & Greenbrier is a narrow-gauge road, but will be widened to standard gauge upon completion of the extension of the West Virginia & Pittsburgh to Philippi.

THE Baltimore & Ohio is extending the State Line road from Uniontown, on the Fayette County Branch, to Morgantown, W. Va., at which point connection will be made with the Fairmont & Morgantown Branch.

IT is stated that upon completion of the extensions of the Philadelphia & Reading, the Western Maryland and the West Virginia railroads, to connect with the Baltimore & Ohio main line at Cherry Run, 65 miles east of Cumberland, a Union station will be put up at that point, plans for which are now being considered.

CONTRACTS for most of the supplies to be used in constructing the new South Baltimore & Curtis Bay Electric Railroad have been awarded, and the work of laying ties will begin in a few days. The electric equipment and overhead wires will be furnished by the Edison General Electric Company of New York. The Armington & Simms Company, of Providence, R. I., has the contract for the engines and boilers. The order for the cars has not yet been placed.

THE South Baltimore Car Works, Curtis Bay, are building 1,000 coal cars of 60,000 lbs. capacity for the George's Creek Coal & Iron Company.

THE Baltimore & Ohio's machine, boiler and blacksmith shops at 58th Street, Philadelphia, were completely destroyed by fire November 6; estimated loss, $10,000.

THE Baltimore & Ohio's new electric light plant and power house at Brunswick, Md., were also destroyed by fire November 9; the loss will approximate $10,000.

THE South Baltimore Car Works and the Ryan & McDonald Manufacturing Company, Curtis Bay, are in the market for electric light plants for their respective shops.

IT is rumored that the Baltimore & Ohio Company will shortly be in the market for a number of passenger, freight and switching engines.

THE Baldwin Locomotive Works have arranged with the Baltimore & Ohio Railroad to make a test of a new compound ten-wheel engine, built for fast express service.

THE Baltimore & Ohio Railroad Company has bought the interests of the Georgetown Railroad, Dock, Elevator & Barge Company, in Georgetown, D. C. The purchase is important, as it gives the Baltimore & Ohio an entrance into Georgetown by means of the Georgetown Railroad. This road is about one mile long, of standard gauge, and runs into the business section of Georgetown. It will be used by the Baltimore & Ohio in connection with the Metropolitan Southern, now being constructed to effect a Southern connection. The Metropolitan Southern commences at Linden Station, on the Metropolitan Branch in Montgomery County, Md., and runs to the Potomac River, about eight miles. The Potomac will be bridged at or near Great Falls, and the extension will be continued in Virginia to unite with the Virginia Midland at Fairfax Station. By the purchase of the Georgetown Railroad, and the building of a short line from a point near the Aqueduct Bridge to connect with that road, an entrance to Georgetown will be effected.

PERSONALS.

J. C. HILL has been re-elected Railroad Commissioner of Virginia for another term.

LOUIS J. BARBOT has been re-elected City Engineer of Charleston, S. C., for another term.

W. M. HUGHES has been appointed Bridge Engineer in the Engineering Department of the city of Chicago.

GEORGE T. MARSH has been appointed Superintendent of the works of the Baltimore Foundry Company at Curtis Bay.

Sir C. GZOWSKI, for several years past President of the Canadian Society of Civil Engineers, has declined a re-election to that office.

PROFESSOR PALMER C. RICKETTS, of the Rensselaer Polytechnic Institute, has been appointed Chief of Engineers of the New York State National Guard.

J. H. AGNEW has resigned his position as Superintendent of the South Carolina Railroad, after holding it for a year. He was previously Master Mechanic of the road.

W. H. MILLER has been appointed Superintendent of Motive Power of the Chicago & Eastern Illinois Railroad. He was recently on the Columbus, Hocking Valley & Toledo.

ALBAN EAVENSON has been appointed Acting Chemist of the Lehigh Valley Railroad, in place of C. P. COLEMAN, who has been transferred to the General Superintendent's office.

P. F. BRENDLINGER and FRANK NEARING, forming the engineering firm of Brendlinger & Nearing, have recently removed their offices from Buffalo, N. Y., to New York City.

HON. D. B. CULBERSON, of Texas, who was mentioned as the successor of the late Walter L. Bragg on the Interstate Commerce Commission, has declined the appointment, preferring to remain in Congress.

GEORGE H. BAKER succeeds Mr. ANGUS SINCLAIR as Editor of the *National Car & Locomotive Builder*. Mr. Baker has had much practical railroad experience, and many opportunities of learning what railroad men want to read. He is well qualified to maintain the excellent standard of the *Car-Builder*.

OBITUARY.

L. HART SELDEN, who died in Chicago, December 9, was born in Hadlyme, Conn., and educated as a civil engineer. He was connected with several lines in the East, and afterward located the Erie & Pittsburgh Railroad in Pennsylvania. He had charge of the building of the Peninsular Railroad—now part of the Chicago & Northwestern—from Escanaba to Marquette, and of some other roads in the Northwest. For some years past he has had a large practice as a consulting engineer.

MAJOR GEORGE W. MCKEE, U. S. A., who died in Philadelphia, November 30, graduated from West Point in 1863, and was appointed Lieutenant in the Ordnance Corps. He was promoted to be Captain in 1874, and Major in 1882. For some time past he had been in command of the Frankford Arsenal. Major McKee was considered one of the best ordnance officers in the Army, and was noted for his scientific attainments. He made some valuable reports and investigations for the Department.

WILLIAM C. ALLISON, who died in Philadelphia, November 30, was born in Chester County, Pa., and at an early age established himself in business as a wagon builder in Philadelphia. After following this with varying success for a number of years, he formed a partnership with John Murphy, and the firm of Murphy & Allison erected extensive shops on Market Street in Philadelphia, where they built a large number of railroad cars. In 1856 the Girard Tube Works were added to this establishment, and ten years later the firm was dissolved by the death of Mr. Murphy, when Mr. Allison formed the firm of W. C. Allison & Sons, which continued until 1881, when the Allison Manufacturing Company was organized with Mr. Allison as president, an office which he continued to hold until his death.

COLONEL WILLIAM E. MERRILL, United States Engineers, died suddenly December 14, while on his way from Cincinnati to St. Louis in an Ohio & Mississippi train. He was 66 years old, and was born in Wisconsin; he was appointed a cadet at West Point from that State, and graduated in 1859. He served through the war in the Engineer Corps, and had been steadily at work ever since, rising gradually to the rank of colonel, and holding many important positions. In 1878 he was sent to Europe to study the application of movable dams in river improvement. For some time past he had been in charge of improvements on the Ohio River and its tributaries. Colonel Merrill's standing as an engineer was very high; he was author of several works on engineering and of many papers for technical societies of which he was a member.

PROCEEDINGS OF SOCIETIES.

American Society of Civil Engineers.—At the regular meeting, November 18, a written discussion by Rudolph Hering on Mr. Rafter's paper on the Rochester Water Works was read.

A paper on the Rolling Friction in Operating the Draw of the Thames River Bridge, by A. P. Boller, Jr., and H. J. Schumacher, was read and briefly discussed by members present. The discussion was continued until the next meeting.

AT the regular monthly meeting, December 2, Mr. J. A. L. Waddell read a paper on some disputed points in Railroad Bridge Designing, taking a strong position in favor of uniform loads, and assuming ample loads in proportioning bridges. The paper was discussed at considerable length by members present.

The following candidates were declared elected: *Members*, Daniel B. Dunn, Macon, Ga.; F. P. Spalding, Washington; James W. Way, St. Louis, Mo.

Associate Members: George G. Earl, Americus, Ga.; Oscar Erlandsen, Poughkeepsie, N. Y.; George T. Richards, Pittsburgh, Pa.; William W. Thayer, Philadelphia, Pa.

Master Mechanics' Association.—Secretary Sinclair gives notice that the only one of the Boston Fund Scholarships in the Stevens Institute of Technology which has so far been awarded is to Mr. George P. Hodgman, son of Mr. S. A. Hodgman, of Wilmington, Del., who is now a student in the institution. Mr. Sinclair will be much pleased to supply information to others who desire to apply for any of these scholarships.

The Committee on Uniform Statements of Locomotive Performance have issued a circular submitting a number of questions to members as to their methods in making our performance sheets, the allowances made and the manner in which mileage is accorded, fuel, oil, etc. This subject is one of importance, and members will do well to answer as soon as possible. The Chairman of the Committee is Mr. George F. Wilson, Superintendent Motive Power, Chicago, Rock Island & Pacific Railroad, and his address is Chicago, Ill.

Engineering Association of the South.—The annual meeting was held in Nashville, Tenn., November 12. The Treasurer submitted his report, showing that the Society was in a prosperous condition, with a balance on hand. The Secretary reported that there were at present 100 members, 3 associate and to junior members. Nine meetings were held last year, at which 12 papers were read. The following new members were elected: Lucian S. Johnson, Peach Orchard, Ky.; John K. Peebles, Nashville, Tenn.

The President then delivered his annual address, including an exhibit of the principal features of industrial development during the past year and the most striking engineering works of the year.

The following officers were elected for 1892: President, A. V. Gude, Atlanta, Ga.; First Vice-President, James Geddes, Nashville, Tenn.; Second Vice-President, F. P. Clute, South Pittsburgh, Tenn.; Secretary, Olin H. Landreth, Nashville, Tenn.; Treasurer, W. B. Ross, Nashville, Tenn.; Directors, E. C. Lewis, W. L. Dudley, W. F. Foster, Nashville, Tenn.; John McLeod, Louisville, Ky.; Hunter McDonald, Savannah, Ga.; Charles B. Percy, Montgomery, Ala.

American Forestry Association.—The annual meeting was to be held in Washington, December 29 and 30. At this meeting it was expected that some action would be taken to draw the attention of Congress to the necessity of legislation to secure the national forest reservation. A large attendance was expected.

NOTES AND NEWS.

Surveying for a Pacific Cable.—The Coast Survey steamer *Albatross* has completed about half of the survey ordered by Congress for a cable from San Francisco to Honolulu. A line of soundings run from San Francisco direct showed the existence of a plateau extending out about 60 miles, with an average depth of 100 fathoms; but at that point there is a sudden drop to 1,200 fathoms, proving the existence of a submarine precipice.

The California coast is generally rocky, and there are few good places for landing a cable. The best found is at Salinas, on the Bay of Monterey, where there is a long stretch of clear, sandy beach, free from stones and rocky projections.

An American Electrical Carriage.—An electrical carriage, invented by William Morrison, of Des Moines, Ia., has been for some time in daily use in that city, and is described by the *Electrical World*, which says that it will soon be taken to Chicago. The carriage itself is of ordinary pattern, with three seats, and will carry six persons. The motor is placed on the rear axle, power being furnished by 24 accumulator cells placed under the seats. The winding of the motor is so arranged that a reversal of the current will cause the carriage to run backward. The steering apparatus is simple and effective.

An Electrical Carriage.—A French electrician, M. de Graffigny, has been experimenting with a tricycle driven by an electric motor, the power for the motor being derived from storage batteries. The tricycle was of the Rudge make, with rubber tires, and the motor was attached directly to the main axle. The storage battery used was a simplification of the

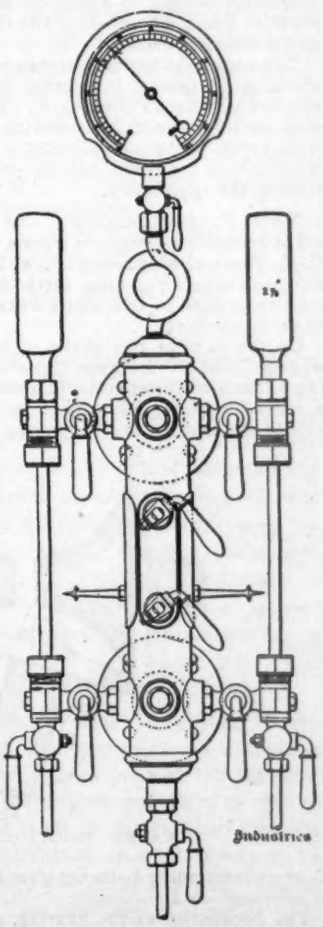
Renard battery; it had 36 elements. The motor used was of the Gramme type. The total weight of the vehicle ready for a start was: Carriage, 73.3 lbs.; storage battery, 47.9; motor and gearing, 33.1; baggage, fresh acid for batteries, etc., 15.4; driver, 138.9; total, 308.6 lbs.

With this carriage a speed was attained of 28 miles an hour on a descending grade, 13¾ miles on a level and 6¼ miles on a heavy up grade. A run of 57½ miles was made without recharging the battery. The cost of running was about 20 cents an hour for the time actually spent on the road.

A New Swiss Mountain Railroad.—A new cable railroad has just been completed up the Rotthorn near the Lake of Brienz, in Switzerland, the summit of which is 7,757 ft. above the sea. The actual ascent from the lower to the upper terminus is 5,510 ft., or 220 ft. more than the Pilatus Railroad, which has heretofore been the highest of these mountain roads. The maximum grade on the new road is 25 per cent.; the works included 10 tunnels and numerous small bridges.

Water Gauge Fittings for Boilers.—Mr. Thomas Urquhart, Locomotive Superintendent of the Grasi-Tsaritzin Railroad in Russia, writes to *Industries* as follows:

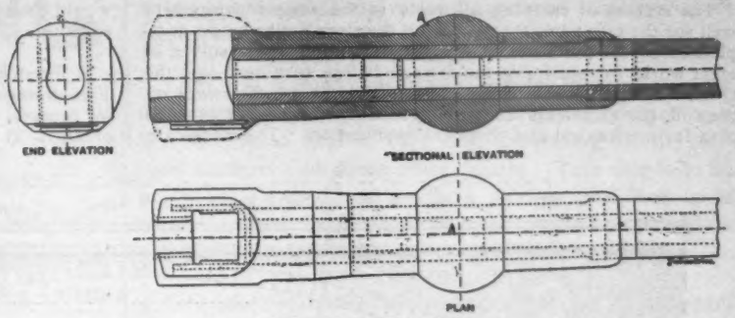
"Undoubtedly false water levels, in a great many cases, end in explosion of boilers or collapse of flues, and investigation generally ends with the conclusion that neither explosion nor collapse would have taken place had the water-gauge connections with the boiler been kept clear of incrustation. According to the old maxim that 'prevention is better than cure,' I beg to bring before the notice of your readers the accompanying illustration of a simple and efficient device in connection with water-gauge mountings used on the Continent, and with which I have had some experience. This apparatus completely obviates the formation of incrustation in the lower connections between glass-gauges and boilers, even with feed water of the worst quality.



WATER GAUGE FITTING.

"A glance at the annexed illustration will explain the action of the anti-incrustator. Each of the steam chambers, composed of pieces of boiler tubing, is placed directly over the glass tubes, with which they are always in communication. These have a total cooling surface of 100 sq. in. By their condensing action they keep up a constant supply of pure water to the gauge glasses, and set up through their connections a return current to the boiler. In some exact experiments which we made, these two steam chambers, placed on the gauge glasses of a Galloway boiler having a stoke-hole temperature of 100° Fahr. and a working pressure of 5 atmospheres, steam was condensed at the rate of 5.74 oz. per hour with the *liquid fuel* used on the Grazi-Tsaritsin Railroad, giving an evaporation of 12 lbs. per lb. of fuel. Thus we arrive at the fact that, with a sacrifice of fuel of ⅛ lb. per day of 12½ hours, we have an absolute automatic guarantee that no incrustation or salt can possibly accumulate in the lower gauge connections, and no trouble exists with leaky cocks which become so by incrustation. This small sacrifice of fuel is a very low premium for the great security effected, and ought to commend itself to steam users on sea and land."

The Adamson Gun.—The illustrations given herewith represent a sectional elevation, end view and plan respectively of a gun invented by the late Mr. Daniel Adamson, and which is



THE ADAMSON GUN.

being introduced by the Adamson Gun Syndicate of London. The principal feature of this type of gun consists in abolishing the trunnions and substituting therefor a ball joint, *A*, or spherical enlargement, which works in a suitable socket on the gun carriage. The advantage claimed for this arrangement is that the gun can be readily trained to cover a much greater range without moving the carriage.

The gun from which our illustrations are taken was made at Bofors, in Sweden, and has been tested by Swedish artillerists with the following results: The gun was fired five times in 20 seconds. An elevation of 25° was found to carry the projectile 26,250 ft., or nearly five miles. Eighty-five rounds were fired with excellent results.

The gun tested was 3.36 in. in callber and 98.43 in. in length. The rifling has 24 grooves 0.295 in. wide and 0.039 in. in depth; the width of the lands is 0.138 in. The volume of the chamber is 161.72 cub. in. The projectile weighs 14.77 lbs., and the charge of black powder 5.51 lbs. With black powder a muzzle velocity of 1,920 ft. was attained, which was increased to 1,970 ft. with smokeless powder.

The claims made for this gun are that it has great strength and durability with respect to its weight, and that the mechanism is simple and easy to manage, and does not require experts for its handling.

An Iceland Bridge.—A new suspension bridge, the first of its kind in Iceland, has recently been erected over the River Olrusaa. The bridge is 372 ft. long and 9 ft. wide. All the materials had to be transported on sledges over the ice during the winter from the nearest harbor, Eyrarbakki. Six steel-wire ropes, weighing 5¼ tons each, and 430 ft. long, were carried upon the shoulders of 180 men, and took two days in transport from Eyrarbakki to the site of the bridge, a distance of about nine miles. A great many difficulties had to be surmounted in the construction, as may be imagined in a country where there are no railroads, and hardly any wheeled vehicles.

Sanitary Improvement in Frankfort.—A long and very interesting report by Chief-Engineer Hirsch on the Sanitary Improvement of Frankfort-on-the-Main was recently published in the *Annales des Ponts et Chaussées*, of which only the briefest abstract is given below:

The works, which extended over a period of 20 years, completely transformed the ancient city. The works of sanitary improvement were of three classes: The distribution of water, the carrying off waste water by sewers and the treatment of sewage.

The old water supply being extremely defective, about 1873 a supply was brought by an aqueduct from the Vogelsberg, amounting to an average of 36½ galls. per inhabitant for the day. This supply was completed in 1885 by pumping from a deep water-bearing stratum at Stadtwald, on the left bank of the Main below Frankfort. This water supply, as it is now managed, is profitable, the annual receipts being considerably in excess of the expenses of maintenance and pumping, leaving a considerable amount to be applied as interest on the cost of the water-works.

The system of sewerage has been established on the principle of carrying off together and by the same conduits the waste water, all refuse susceptible of being washed out, the surplus rain water and drainage water. This system is composed of collecting sewers following as nearly as possible the lines of level of the ground, and of secondary sewers built on the lines of greatest fall and at right angles to the river. On either bank these are divided into two systems, the upper and the lower. The large collecting sewers discharge into the Main at a great distance below the city. The flushing and cleaning of the sewers is done by the surplus water, and ventilation is effected by the house discharge-pipes, which form chimneys. Besides

these pipes there are a certain number of special ventilators carried through chimneys built in the towers of the wall surrounding the old city.

The system of carrying all waste to the sewers works very well for the city; but the people on the river banks below complained of the pollution of the waters, and it was resolved to erect works for purifying the sewage before turning it into the river. As the local circumstances forbid the use of sewage on the soil, the engineers were obliged to have recourse to some plan for mechanical and chemical purification. The works are situated about three miles below the city. The foul water is carried there by the collecting sewers, one of which is carried underneath the Main by a siphon. There are two groups of six settling basins, each group being able to treat in ordinary times about 700,000 cub. ft. per day, and twice that quantity in rainy seasons. In these settling basins the heavier matters held in suspension are deposited, and from the basins the water is passed through gratings which retain floating bodies. The settling works very well, thanks to the slowness of the movement of water through the basins and the use of chemical reagents—sulphate of alumina and chalk. About 2,200 lbs. of the first named and 550 lbs. of the second are used to 210,000 cub. ft. of water. The cost is very small, amounting to about 25 cents per inhabitant of the city per year, including in this sum interest on the cost of the works and a sinking fund, as well as the cost of working.

It may be mentioned that in 1885 about 78 per cent. of all the houses in the city were connected with the sewers, and 70 per cent. used the city water. That proportion has been considerably increased since that time.

Results from a hygienic point of view have been very marked. Before 1870 the mortality resulting from typhoid fever showed for several years an average of 71 deaths per year to 100,000 persons. Beginning with 1875, the date at which the new works commenced to produce an effect, this mortality decreased steadily to 16 in 1885, showing a reduction of over 77 per cent., and it is stated now that this terrible disease has now almost entirely disappeared, very few cases having been reported by the health authorities in the last three or four years.

A Submarine Boat.—At the yard of the Detroit Boat Works, Detroit, a few days ago the submarine boat, about which a great deal has been written, was launched. The boat was designed by Fred. A. Ballin, naval architect, and is the property of George A. Baker, of Chicago, who wishes to use her for testing an invention upon which he has been at work for a long time past. The invention consists in reversible propellers, working on each side of the boat amidships. Their duty is to propel as well as regulate the desired immersion. The boat is 40 ft. long, 9 ft. wide and 14 ft. deep, and was built of wood instead of iron or steel for economy's sake. The power is steam, a Roberts safety pipe boiler and Willard engine being used. Compressed air can be stored in the hull.—*Cleveland Marine Review.*

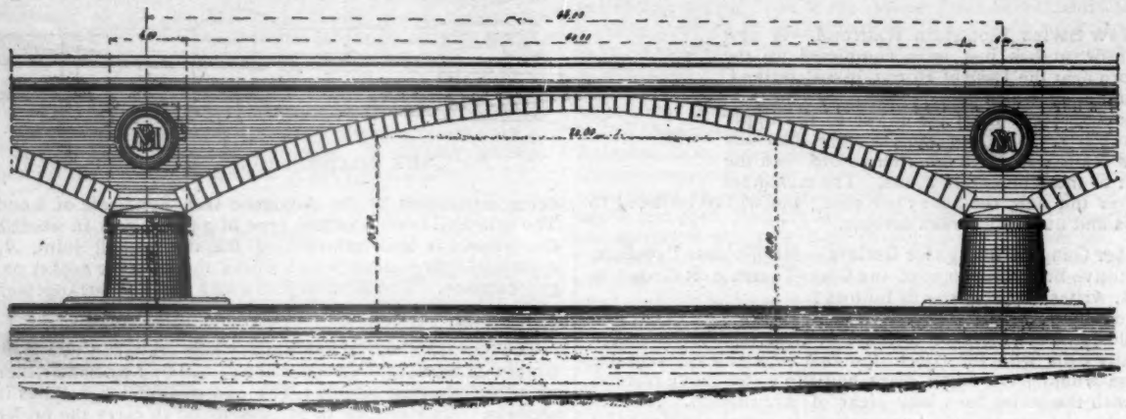
Steam Power of the World.—According to a writer in the *Revue Scientifique*, of Paris, the power furnished by the steam-engines of the whole world represents the labor of 1,000,000,000 men; that is, of more than twice the number of working-men in existence.

In this calculation the United States stands first, being put down as having steam-engines with a total of 7,500,000 H.P.; Great Britain has a total of 7,000,000 H.P.; Germany, 4,500,000 and France, 3,000,000.

These figures do not include the locomotives, the total number of which in the world is estimated at 105,000, representing a total of 5,500,000 to 7,000,000 H.P.

All the steam-engines of the world, including locomotives, would produce a force equivalent to 49,000,000 H.P. if working together.

A French Masonry Bridge.—There has been recently among French engineers a tendency to return to the use of masonry for bridges, especially in localities where suitable stone can be obtained at a reasonable cost. One instance of this is a new bridge over the Saone at Verjux, which has been named the Boucicaut Bridge, in honor of M. Boucicaut, a wealthy merchant of Paris, who paid for the construction of the bridge as a gift to his native town.

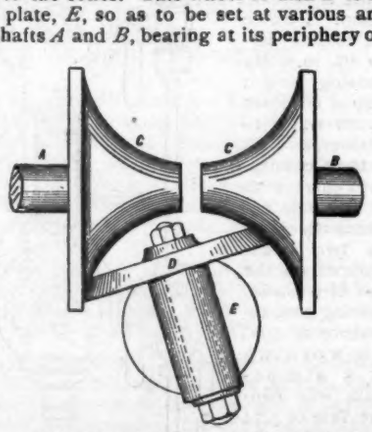


ARCH OF THE BOUCICAUT BRIDGE, VERJUX, FRANCE.

The structure has five arches carried on four piers and two abutments. One of the arches is shown in the accompanying engraving, from *Le Genie Civil*. The arches are all of the same size, having 131.2 ft. span and 16.4 ft. rise. The radius varies from 177 ft. at the summit to 75.5 ft. at the spring. The work is entirely of cut stone, and its cost was about $97,000, not including the approaches.

Novel Friction Gearing.—The device illustrated in the diagram herewith we engrave from a recent patent granted to Mr. C. C. Yates, of Mechanics Falls, Me. It is deserving of attention, and superior to most methods now in use for varying the relative motion of two shafts when a small amount of power is to be transmitted.

On the ends of two shafts, *A* and *B*, are fixed two conical wheels *C* and *C*. Between these is an intermediate wheel bearing on both of the cones. This wheel or disk *D* is mounted on a swiveling plate, *E*, so as to be set at various angles to the axis of the shafts *A* and *B*, bearing at its periphery on the cones



YATES' FRICTION GEARING.

C, at corresponding distances from the center, and varying their relative motion accordingly.

The peculiarity of the gearing, aside from its extreme simplicity, is that the surfaces move together uniformly, and there is not that twisting and grinding action common to other forms of friction gearing when employed for a similar purpose. This method is one especially applicable to the feed motion of machine tools, but would require different proportions from those shown in the diagram. The main disk *C* should be larger in diameter and with less range of variation.—*Industry, San Francisco.*